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PERMIAN BRACHIOPODS FROM
CENTRAL OREGON

(WITH 12 PLATES)

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7. *Probolionia*, *Marginifera?*, and *Pleurohorridonia?*.
8. *Krotovia*, *Probolionia*, and *Echinoconchus*.
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INTRODUCTION

The Permian brachiopods described herein come from a little-known area of Paleozoic rocks lying about 30 miles east of the geographical center of Oregon. It is about 8 miles southwest of Suplee and about 15 miles southeast of Paulina. The country is in the headwaters of Grindstone and Twelvemile Creeks which are tributaries of the Crooked River. The area is one of great structural complexity which includes Mississippian, Pennsylvanian, and Permian beds overlain by Triassic and Jurassic deposits.

Washburne (1903) was the first to report the Paleozoic sediments of this region, but Packard (1928, 1932) was the first to recognize Mississippian and Permian deposits. In 1937 Merriam and Berthiaume (published in 1943) made studies and a geological map of part of the region. Read and Merriam (1940) visited this area and collected Paleozoic plants. Merriam (1942) described Mississippian and Permian corals from these rocks. The collections made by Merriam, Berthiaume, and Read, and those earlier assembled by Packard and his students, include many interesting Mississippian species as well as the Permian specimens described below. I was invited by Dr. Merriam to describe these fossils. The Permian (Coyote Butte formation) fossils are the first to be finished but description of the Mississippian brachiopods is scheduled for the near future.

The collection submitted by Dr. Merriam consists of materials collected by University of Oregon students prior to the studies of Merriam and Berthiaume. Unfortunately, the geographic and stratigraphic data with many of these specimens are inadequate. Nevertheless, for the sake of completeness it was necessary to describe and

illustrate a few of them. The brachiopods described herein are of great interest because of their obvious affinities to Russian species and because of the occurrence of genera never, or only seldom, seen in more familiar areas of Permian rock in this country. When first reported these brachiopods were thought to be of Lower Permian age (Merriam and Berthiaume, 1943, p. 158) but this more detailed study requires a revision of this view. They now appear to be of Medial Permian age with probable affinities to the fauna of the lower part of the Word formation of west Texas.

DESCRIPTION OF COYOTE BUTTE FORMATION

The following description of the Coyote Butte formation is revised from Merriam and Berthiaume (1943). The youngest Paleozoic beds of the area comprise a sequence in which massive limestones form the most conspicuous exposures. These produce prominent ridges, buttes, and small circular hills or knobs subsidiary to the main ridge slopes. Steeply dipping strata forming the crest of Coyote Butte near the southern limit of the map (text fig. 1) constitute the type section of the formation. The Coyote Butte beds here lie in the north limb of a tight syncline overturned toward the south. Another bold outcrop of the formation appears in the belt extending north-northeast from the vicinity of Tuckers Butte for about 4 miles. A third area of Permian beds includes exposures in the northeast portion of the map, one tongue of which extends southwest beyond Twelve-mile Creek where it is covered by Tertiary lava.

At the type section the lower portion of the Coyote Butte formation is generally a light olive-gray limestone, often crinoidal and locally containing fusulinids in great abundance. Higher in the section, at the summit of Coyote Butte, the limestone becomes purer, finer grained, deep olive gray in color and possesses more distinct bedding. In this upper portion fusulinids are less frequently met while brachiopods are common.

The character of the Coyote Butte limestone throughout the area is similar to that found at the type locality. Coarse crinoidal debris is abundant at several localities not far above the lower contact of the formation. Conglomeratic phases of the basal limestone also occur locally. At locality S73 in the eastern part of the area rounded chert pebbles and subangular chert grains are distributed throughout a crinoidal and fusulinid-bearing limestone. Another conglomeratic phase at the base of the limestone occurs on the west side of Spotted Ridge. Here pebbles of green, white, red, and black chert become

so abundant as to form a calcareous conglomerate. It seems probable that these pebbly facies represent a local reworking of underlying Pennsylvanian sediments.

Limestones of the Coyote Butte formation are interbedded with large amounts of sandstones. Furthermore the discontinuous nature of some of the limestone exposures leads to the impression that these deposits are lenticular within the arenaceous facies. Generally speaking, exposures of the sands are poor, while the limestones form promi-

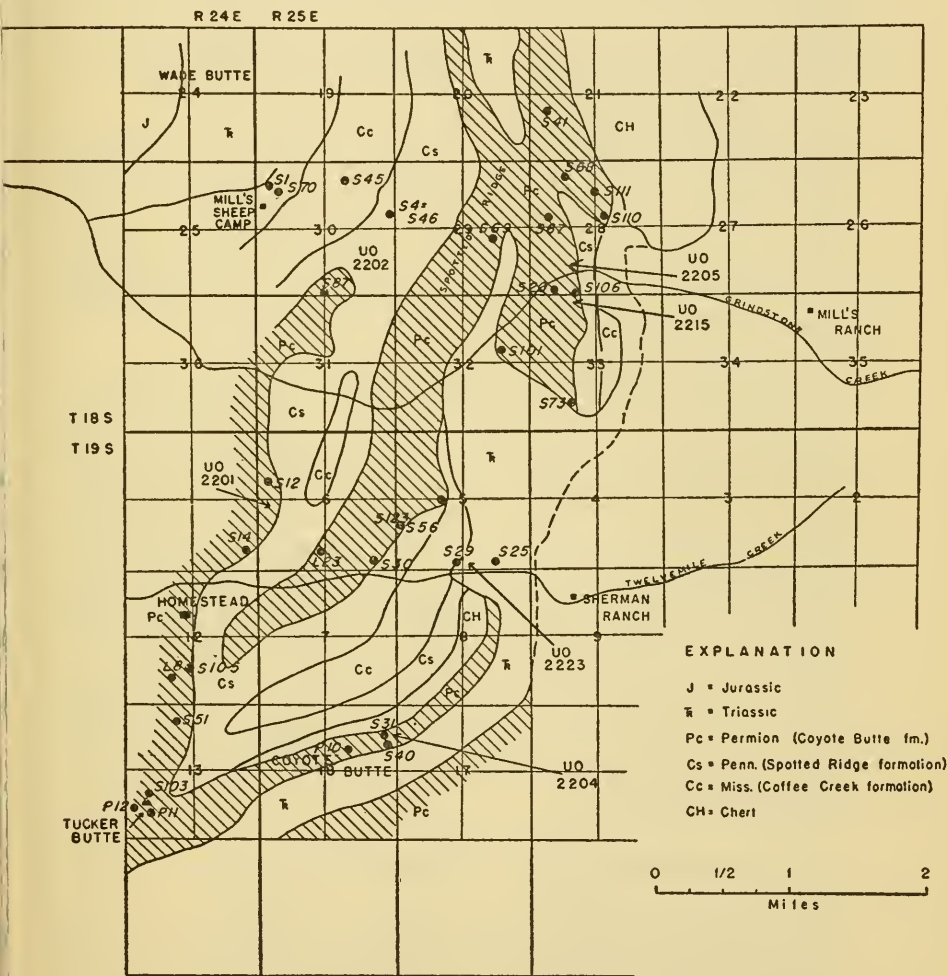


FIG. 1.—Map of Grindstone-Twelvemile Creeks area, central Oregon, showing distribution Permian rocks (oblique lines) and localities (numbers) from which brachiopods were taken. Map redrawn after Merriam and Berthiaume, 1943.)

nent linear or circumscribed exposures. Northeast of locality S123 in the center of the map several zones of sandstone float alternately with fusulinid limestones.

Large amounts of insoluble materials, such as chert and sand grains, occur locally in the Permian limestone. At locality S68 in the northeastern portion of the area, dark, irregular chert layers up to 10 inches in thickness are interbedded with the limestone. In other occurrences the siliceous material replaces the limestone as irregular patches and permeates it in varying degree. In some instances, as along the southwest side of Spotted Ridge, the limestones are dolomitic and in extreme cases are apparently recrystallized, giving the rock a light gray or pale cream color.

Thickness.—At the type section on Coyote Butte the Permian beds measure approximately 900 feet. Estimates of thickness on Spotted Ridge and north of Tuckers Butte are approximately the same. However, exact thicknesses cannot be given because bedding is poor and folds within the massive limestone are difficult to unravel. Where the formation is to a great extent arenaceous, exposures are poorly developed. Unconformable relation of the Permian to overlying beds further conceals their thickness in some localities.

Stratigraphic relations.—The Coyote Butte is unconformable on the Pennsylvanian Spotted Ridge formation. This relation is suggested by pinching out of the Pennsylvanian strata in sec. 5, T. 19 S., R. 25 E., where the contact between Coyote Butte limestone and the Lower Carboniferous Coffee Creek formation is apparently depositional. At locality S105 north of Tuckers Butte an exposure of the lower contact of the Permian shows a slight angular discordance and a definite truncation of the conglomeratic and sandy beds of the underlying formation. On the basis of lithology and position the latter beds are presumed to be the Spotted Ridge formation. Furthermore, on the west side of Spotted Ridge and at several other localities the basal Coyote Butte strata are very pebbly limestones and calcareous conglomerates, probably indicating reworking of subjacent Pennsylvanian clastics.

LOCALITIES FROM WHICH BRACHIOPODS WERE COLLECTED

Some of the localities listed below are uncertain and sketchy because of the early lack of maps in this region. Inasmuch as good fossils are difficult to find in this complicated area, it seemed best to use all the specimens regardless of the sketchy quality of some of the locality descriptions. Completeness of faunal description seems a

worthy aim in such a little-known region. Fortunately these specimens are few in number.

UNIVERSITY OF OREGON NUMBERS

U.O.

2201. Large limestone butte immediately south of the SW cor. NW $\frac{1}{4}$ sec. 6, T. 19 S., R. 25 E., approximately = S12.
Echinoconchus inexpectatus
 Cooper
- 2201-1. On the north side of the butte at the base.
Anidanthus minor Cooper *Pseudomartinia* aff. *P. semiglobosa*
Dielasma rectimarginatum (Tschernyschew)
 Cooper *Punctospirifer* sp. 2
Echinoconchus inexpectatus *Rhynchopora magna* Cooper
 Cooper *Squamularia rostrata* (Kutorga)
Kochiproductus transversus
 Cooper
Krotovia pustulata
 (Keyserling)
- 2201-2. Between 50 and 100 feet up the side of the butte.
Anidanthus minor Cooper *Proboscidella?* *carinata* Muir-
Avonia oregonensis Cooper Wood and Cooper
Muirwoodia transversa Cooper *Rostranteris sulcatum* Cooper
- 2201-3. From the very top of the hill.
Chonetes sp. 1
- 2201-4. Outcrop just north of the main point right in the NE cor. sec. 1 = S12.
Alexenia? *occidentalis* Cooper *Spiriferella draschei* (Toula)
Probolonia posteroreticulata *Stenoscisma mutabile oregonense*
 Cooper
Rhynchopora sp. *S.* cf. *S. plicatum* (Kutorga)
2202. "Triangulation Hill," a larger hill 2,800 feet from the SE cor. sec. 30, T. 18 S., R. 25 E., on section line fence = S87.
Echinoconchus inexpectatus *Kochiproductus* cf. *K. porrectus*
 Cooper (Kutorga)
- 2202-1. Locality at the top of the hill.
Stenoscisma cf. *S. plicatum*
 (Kutorga)
- 2202-2. Ledge on south side of hill.
Alexenia? *occidentalis* Cooper *Muirwoodia transversa* Cooper
Antiquatonia sulcata Cooper *Neospirifer* sp. 1
Avonia oregonensis Cooper *Probolonia posteroreticulata*
Chonetes sp. 1 Cooper
Dielasma brevicostatum Cooper *Pseudomartinia* aff. *P.*
Kochiproductus cf. *K. porrectus* (Kutorga) *semiglobosa* (Tschernyschew)
Marginiifera? *costellata* *Rhynchopora magna* Cooper
 Cooper *Spiriferella draschei* (Toula)
Stenoscisma cf. *S. plicatum*
 (Kutorga)

U.O.

- 2202-3. Lowest ledge on north slope of hill.
Avonia oregonensis Cooper *Probolionia elongata* Cooper
Probolionia posteroreticulata
 Cooper
- 2202-4. 100 yards due west of triangulation point.
Squamularia rostrata
 (Kutorga)
- 2202-5. Outcrop 450 feet due west of triangulation point.
Avonia oregonensis Cooper *Probolionia posteroreticulata*
 Cooper
- 2202-6. East slope of hill 210 feet from top.
Avonia oregonensis Cooper *Stenoscisma* cf. *S. plicatum*
 (Kutorga)
2204. Coyote Butte, fossil localities in E $\frac{1}{2}$ NE $\frac{1}{4}$ sec. 18 and NW $\frac{1}{4}$ sec. 17, T. 19 S., R. 24 E., a string of hills trending northeast-southwest = S40.
- 2204-1. Westernmost butte of the string.
Anidanthus minor Cooper *Rhynchopora magna* Cooper
Avonia oregonensis Cooper *Squamularia rostrata* (Kutorga)
Echinoconchus inexpectatus *Stenoscisma mutabile oregonense*
 Cooper Cooper
Proboscidella? *carinata*
 Muir-Wood and Cooper
- 2204-2. Approximately 1 mile southwest of Coyote Butte.
Alexenia? *occidentalis* Cooper
- 2204-3. From the top of the westernmost butte.
Alexenia? *occidentalis* Cooper *Marginifera?* *profundosulcata*
Antiquatonia sulcata Cooper Cooper
Avonia oregonensis Cooper *Muirwoodia transversa* Cooper
Derbyia sp. 2 *Probolionia elongata* Cooper
Dielasma brevicostatum Cooper *Spiriferella draschei* (Toula)
Echinoconchus inexpectatus *S. parva* Cooper
 Cooper *Squamularia rostrata* (Kutorga)
Krotovia pustulata *Stenoscisma mutabile oregonense*
 (Keyserling) Cooper
Lingula sp.
2205. "Lunch Rock," just west of the road, north side of Grindstone Creek and east side of Lunch Creek, SW $\frac{1}{4}$ sec. 28, T. 18 S., R. 25 E.
- 2205-1. The original locality just north of the road = 637.
Waagenoconcha parvispinosa
 Cooper
- 2205-5. 100 yards from "Lunch Rock" and the outcrops up Lunch Creek to the north for 250 yards = 636.
Cleiothyridina attenuata *Spiriferella draschei* (Toula)
 Cooper *Stenoscisma biplicatoideum*
Dielasma brevicostatum Cooper Cooper
Pleurohorridonia? *elongata*
 Cooper
2207. Central Bucher Butte, about 100 feet down the slope near the east central edge of sec. 17, T. 19 S., R. 24 E. (not shown on map).
Anidanthus minor Cooper *Spiriferella draschei* (Toula)

U.O.

2207-2. Same.

Anidanthus minor Cooper2210. Small limestone outcrop due west from Iron Mountain, and just west of the road, and N.15° W. of Christenson Brothers ranch, SE $\frac{1}{4}$ sec. 35, T. 17 S., R. 25 E. (not shown on map).*Spiriferella draschei* (Toula)2211. Small outcrop right behind Suplee, just due south of the Mesozoic rim, NE $\frac{1}{4}$ sec. 35, T. 17 S., R. 25 E. (not shown on map).

2211-2. On rim in limestone lens on central-north edge sec. 35 (not shown on map).

Alexenia? *occidentalis* Cooper2215. Large limestone knob on the south side of Grindstone Creek, SW $\frac{1}{4}$ sec. 33, T. 18 S., R. 25 E.

2215-1. Same as above.

Anidanthus minor Cooper2216. "Petrified snake locality," ledge of crinoidal limestone on second ridge south of Clark's place, SE $\frac{1}{4}$ sec. 33, T. 17 S., R. 25 E. (not shown on map).

2216-1. Same.

Anidanthus minor Cooper*Probolonia posteroreticulata**Kochiproductus transversus*

Cooper

Cooper

2216-2. Same.

Dielasma brevicostatum

Cooper

2218. Grindstone-Twelvemile Creeks area.

2218-2. Same.

Punctospirifer sp. 1

2219. Same as 2218.

2219-1. Same.

Pseudomartinia aff. *P. semiglobosa* (Tschernyschew)

2223. Small limestone outcrop near the south edge, center sec. 5, T. 19 S., R. 25 E., and just north of Twelvemile Creek and the road = S29.

2223-2. Float from SW cor. sec. 5 and on small hill just north of the dam.

Rostranteris sulcatum Cooper

2225. Same as 2218.

Pseudomartinia aff. *P. semiglobosa* (Tschernyschew)

613. Permian, Grindstone-Twelvemile Creeks area.

Rhynchopora magna Cooper

614. Permian, Grindstone-Twelvemile Creeks area.

Alexenia? *occidentalis* Cooper *Spiriferella draschei* (Toula)*Kochiproductus* cf. *K.**porrectus* (Kutorga)

633? Permian, Grindstone-Twelvemile Creeks area.

Squamularia rostartia

(Kutorga)

U.O.

636. "Lunch Creek" = U.O. 2205-5.
Avonia oregonensis Cooper *Rhynchopora magna* Cooper
Echinoconchus inexpectatus Cooper *Waagenoconcha parvispinosa* Cooper
637. "Lunch Creek" = U.O. 2205-1.
Leptodus? sp. 1 *Rhynchopora magna* Cooper
Meckella sp. 1
638. Permian, Suplee Anticline.
Alexenia? *occidentalis* Cooper *Proboscidella?* *carinata* Muir-Wood
Antiquatonia sulcata Cooper and Cooper
Echinoconchus inexpectatus Cooper *Rhynchopora magna* Cooper
Krotovia pustulata Cooper *Spiriferella draschei* (Toula)
(Keyserling) *Squamularia rostrata* (Kutorga)
Muirwoodia transversa Cooper *Stenoscisma mutabile oregonense* Cooper
Probolonia posteroreticulata Cooper
639. Permian, Grindstone-Twelvemile Creeks area.
Alexenia? *occidentalis* Cooper *Rhynchopora magna* Cooper
Echinoconchus inexpectatus Cooper *Spiriferella draschei* (Toula)
Cooper

MERRIAM AND BERTHIAUME NUMBERS

F-number localities

F. General float.

- Alexenia?* *occidentalis* Cooper *Rhynchopora magna* Cooper
Echinoconchus inexpectatus Cooper
Cooper
Muirwoodia transversa Cooper *Waagenoconcha parvispinosa*

L-number localities

- L8. NW $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 12, T. 19 S., R. 24 E., 1 mile north of Tucker Butte.
Alexenia? *subquadrata* Cooper *Muirwoodia transversa* Cooper
Anidanthus minor Cooper *Rhynchopora magna* Cooper
Avonia oregonensis Cooper *Spiriferella draschei* (Toula)
Cleiothyridina gerardi Cooper *Squamularia rostrata* (Kutorga)
(Diener) *Stenoscisma biplicatoideum* Cooper
Composita sp. 1 *S. mutabile oregonense* Cooper
Krotovia pustulata
(Keyserling)
Marginifera? *profundosulcata*
Cooper
- L23. W. side center line SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 6, T. 19 S., R. 25 E., about 1 $\frac{3}{4}$ miles west-northwest of Sherman Ranch.
Avonia oregonensis Cooper *Spiriferella draschei* (Toula)
Dielasma rectimarginatum
Cooper

P-number localities

- P10. NE $\frac{1}{4}$ SW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 18, T. 19 S., R. 25 E., northeast of Coyote Butte.
Alexenia? occidentalis Cooper *Muirwoodia transversa* Cooper
Antiquatonia reticulata Cooper *Probolionia posteroreticulata*
A. sulcata Cooper Cooper
Cleiothyridina gerardi *Rhynchopora magna* Cooper
(Diener) *Spiriferella draschei* (Toula)
Echinoconchus inexpectatus *Squamularia rostrata* (Kutorga)
Cooper *Stenosisma biplicatoideum* Cooper
Kochiproductus transversus *S. mutabile oregonense* Cooper
Cooper
Krotovia parva Cooper
K. pustulata (Keyserling)
- P11. NE $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 13, T. 19 S., R. 25 E., Tuckers Butte.
Echinoconchus inexpectatus *Rostranteris merriami* Cooper
Cooper *Squamularia rostrata* (Kutorga)
Kochiproductus transversus
Cooper
- P12. Center NW $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 13, T. 19 S., R. 24 E., Tuckers Butte.
Alexenia? occidentalis Cooper *Dielasma brevicostatum* Cooper
Anidanthus minor Cooper *Squamularia rostrata* (Kutorga)
Chonetes sp. 1 *Waagenoconcha parvispinosa*
Cleiothyridina gerardi Cooper
(Diener)

S-number localities

- S1. SW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 30, T. 18 S., R. 25 E., about 4 miles N. 35° W. of Sherman Ranch.
Echinoconchus inexpectatus
Cooper
- S4. See S46.
- S12. NW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 6, T. 19 S., R. 25 E., about 2½ miles N. 69° W. of Sherman Ranch.
Alexenia? occidentalis Cooper *Proboscidella? carinata* Muir-Wood
Antiquatonia sulcata Cooper and Cooper
Avonia oregonensis Cooper *Pseudomartinia berthiaumei* Cooper
Kochiproductus transversus *P. aff. P. semiglobosa*
Cooper (Tschernyschew)
Marginifera? profundosulcata *Spiriferella draschei* (Toula)
Cooper
Probolionia posteroreticulata
Cooper
- S14. Center E $\frac{1}{2}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 1, T. 19 S., R. 24 E., ½ mile northeast of Homestead.
Avonia oregonensis Cooper *Linoproductus* cf. *L. lutkewitschi*
Echinoconchus inexpectatus (Stepanow)
Cooper *Stenosisma mutabile oregonense*
Cooper

- S20. SE $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 28, T. 18 S., R. 25 E., about 2 $\frac{1}{4}$ miles north of Sherman Ranch.
Antiquatonia reticulata Cooper *Rhynchopora magna* Cooper
Dielasma? truncatum Cooper *Stenoscisma americanum* Cooper
Neospirifer sp. *S. mutabile oregonense* Cooper
- S25. SW cor. SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 5, T. 19 S., R. 24 E., about $\frac{3}{4}$ mile northwest of Sherman Ranch.
Chonetes sp. (not described or figured) *Echinoconchus inexpectatus* Cooper
Hustedia sp. 1
- S29. SE cor. SW $\frac{1}{4}$ sec. 5, T. 19 S., R. 25 E., about 1 mile west-northwest of Sherman Ranch.
Echinoconchus inexpectatus Cooper *Probolionia posteroreticulata* Cooper
- S30. SW $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 6, T. 19 S., R. 25 E., 1 $\frac{1}{2}$ miles west-northwest of Sherman Ranch.
Alexenia? occidentalis Cooper *Marginifera? brevisulcata* Cooper
Avonia oregonensis Cooper *Probolionia posteroreticulata* Cooper
Chonetes pygmaeus Cooper Cooper
- S31. SE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 18, T. 19 S., R. 25 E., Coyote Butte, about 1 $\frac{3}{4}$ miles southwest of Sherman Ranch.
Chonetes sp. 1
- S39. Top of Coyote Butte (not located on map).
Alexenia? occidentalis Cooper *Marginifera? costellata* Cooper
Echinoconchus inexpectatus Cooper *Rhynchopora magna* Cooper
Cooper
- S40. NE cor. SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 18, T. 19 S., R. 25 E., east side of Coyote Butte.
Avonia oregonensis Cooper *Muirwoodia transversa* Cooper
Echinoconchus inexpectatus Cooper *Probolionia posteroreticulata* Cooper
Cooper
Krotovia parva Cooper *Rhynchopora magna* Cooper
K. pustulata (Keyserling) *Spiriferella draschei* (Toula)
Marginifera? profundosulcata Cooper *Stenoscisma mutabile oregonense* Cooper
Cooper
- S41. About center NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 21, T. 18 S., R. 25 E., about 3 $\frac{3}{4}$ miles north of Sherman Ranch.
Alexenia? occidentalis Cooper *Paeckelmannia* aff. *Chonetes alatus* Cooper
Anidanthus minor Cooper Stuckenberg
Krotovia pustulata Cooper *Rostranteris merriami* Cooper
(Keyserling) *R. sulcatum* Cooper
Kochiproductus transversus Cooper *Squamularia rostrata* (Kutorga)
Cooper *Stenoscisma mutabile oregonense* Cooper
Marginifera? profundosulcata Cooper
- S43. Equals S46.
- S45. General float near center NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 30, T. 18 S., R. 25 E.
Avonia oregonensis Cooper *Lino-productus* cf. *L. lutkewitschi* (Stepanow)
Cleiothyridina attenuata Cooper
Cooper *Marginifera? brevisulcata* Cooper

- Echinoconchus inexpectatus* Cooper
Rhynchopora magna Cooper
- S46. SE $\frac{1}{4}$ SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 30, T. 18 S., R. 25 E., about 3 $\frac{1}{4}$ miles N. 25° W. of Sherman Ranch = S4.
Anidanthus minor Cooper
Antiquatonia sulcata Cooper
Avonia oregonensis Cooper
Crurithyris sp. 1
Echinoconchus inexpectatus Cooper
Krotovia pustulata (Keyserling)
Marginifera? costellata Cooper
Marginifera? costellata
M.? multicostellata Cooper
- Muirwoodia transversa* Cooper
Probolonia elongata Cooper
P. posteroreticulata Cooper
Rhynchopora magna Cooper
Spiriferella draschei (Toula)
Squamularia rostrata (Kutorga)
Stenosisma mutabile oregonense Cooper
Waagenoncha parvispinosa Cooper
- S47. NW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 28, T. 18 S., R. 25 E., about 2 $\frac{1}{2}$ miles north of Sherman Ranch (not located on map).
Antiquatonia sulcata Cooper
Chonetes sp. 1
Echinoconchus inexpectatus Cooper
Pleurohorridonia? elongata Cooper
- Spiriferella draschei* (Toula)
Stenosisma buplicatoideum Cooper
S. mutabile oregonense Cooper
- S49. Several zones of the Permian at Coyote Butte (not located on map).
Alexenia? occidentalis Cooper
Avonia oregonensis Cooper
Linoproductus cf. *L. lutke-witschi* (Stepanow)
Marginifera? brevisulcata Cooper
M.? profundosulcata Cooper
- Probolonia elongata* Cooper
P. posteroreticulata Cooper
Proboscidella? carinata Muir-Wood and Cooper
Rhynchopora magna Cooper
R. sp.
Spiriferella draschei (Toula)
- S50. General collection of Permian including several zones, Coyote Butte (not located on map).
Alexenia? occidentalis Cooper
Anidanthus minor Cooper
Echinoconchus inexpectatus Cooper
Kochiproductus transversus Cooper
Lingula sp.
Muirwoodia transversa Cooper
- Proboscidella? carinata* Muir-Wood and Cooper
Rostranteris merriami Cooper
Spiriferella draschei (Toula)
Stenosisma mutabile oregonense Cooper
- S51. About center NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 13, T. 19 S., R. 24 E., about $\frac{1}{2}$ mile north-northeast of Tuckers Butte.
Antiquatonia sulcata Cooper
Pleurohorridonia? elongata Cooper
- Spiriferella draschei* (Toula)
- S56. SW $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 5, T. 19 S., R. 25 E., about 1 $\frac{1}{2}$ miles northwest of Sherman Ranch.
Krotovia pustulata (Keyserling)
- Rhynchopora magna* Cooper
Spiriferella draschei (Toula)

- Marginifera?* *profundosulcata* *Squamularia rostrata* (Kutorga)
Cooper
- S67. Just south of center SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 28, T. 18 S., R. 25 E., 2 miles northwest of Mills Ranch.
Antiquatonia reticulata Cooper *A. sulcata* Cooper
- S68. Center W $\frac{1}{2}$ NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 28, T. 18 S., R. 25 E., about 3 $\frac{1}{2}$ miles north of Sherman Ranch.
Chonetes sp. 1 *Probolionia elongata* Cooper
Derbyia sp. 2 *Spiriferella draschei* (Toula)
- S69. SE cor. NE $\frac{1}{4}$ NW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 29, T. 18 S., R. 25 E., 2 $\frac{3}{4}$ miles N. 12° W. of Sherman Ranch.
Probolionia posteroreticulata
Cooper
- S70. SW cor. SE $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 30, T. 18 S., R. 25 E., about 4 miles N. 30° W. of Sherman Ranch and near Mills sheep camp.
Echinoconchus inexpectatus *Krotovia pustulata* (Keyserling)
Cooper
- S87. Just N. of center S. line sec. 30, T. 18 S., R. 25 E., $\frac{3}{4}$ mile southeast of Mills sheep camp.
Anidanthus minor Cooper *Pleurohorridonia?* *elongata* Cooper
Avonia oregonensis Cooper *Probolionia posteroreticulata*
Cleiothyridina attenuata Cooper
Cooper *Rhynchopora magna* Cooper
Dielasma brevicostatum *Spiriferella draschei* (Toula)
Cooper *Spiriferellina pauciplicata* Cooper
Echinoconchus inexpectatus *Stenoscisma* cf. *S. plicatum*
Cooper (Kutorga)
Kochiproductus cf. *K. porrectus* (Kutorga) *Wellcrella multiplicata* Cooper
Krotovia pustulata (Keyserling)
- S101. SW $\frac{1}{4}$ SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 32, T. 18 S., R. 25 E., 2 miles N. 15° W. of Sherman Ranch.
Derbyia sp. 1 *Pseudomartinia berthiaumei*
D. sp. 2 Cooper
Krotovia aff. *K. barenzi* *Punctospirifer* sp. 1
(Miloradovitch) *Rhipidomella* sp. 1
Neospirifer sp. 1 *Spiriferellina* sp. 1.
- S103. SW $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 13, T. 19 S., R. 24 E., Tuckers Butte.
Alexenia? *occidentalis* Cooper *Linoproductus* cf. *L. lutkewitschi*
Anidanthus minor Cooper (Stepanow)
Antiquatonia sulcata Cooper *Muirwoodia transversa* Cooper
Avonia oregonensis Cooper *Neospirifer* sp. 1
Chonetinella sp. 1 *Probolionia posteroreticulata*
Cleiothyridina gerardi Cooper
(Diener) *Rhynchopora magna* Cooper
Derbyia sp. 1 *R.* sp.
Dielasma brevicostatum Cooper *Spiriferella draschei* (Toula)

<i>Kochiproductus transversus</i> Cooper	<i>Squamularia rostrata</i> (Kutorga)
<i>Krotovia pustulata</i> (Keyserling)	<i>Stenosisma</i> cf. <i>S. plicatum</i> (Kutorga)
	<i>Waagenoconcha parvispinosa</i> Cooper

S106. SW $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 28, T. 18 S., R. 25 E., 2 $\frac{1}{2}$ miles due north of Sherman Ranch.

<i>Alexenia?</i> <i>subquadrata</i> Cooper	<i>Probolionia posteroreticulata</i> Cooper
<i>Avonia oregonensis</i> Cooper	<i>Squamularia rostrata</i> (Kutorga)
<i>Kochiproductus</i> cf. <i>K.</i> <i>porrectus</i> (Kutorga)	<i>Stenosisma</i> cf. <i>S. plicatum</i> (Kutorga)

S111. About $\frac{1}{4}$ mile north of center sec. 28, T. 18 S., R. 25 E., 1 $\frac{3}{4}$ miles north-west of Mills Ranch.

<i>Chonetes</i> sp. 1	<i>Linoproductus</i> cf. <i>L. lukewitschi</i> (Stepanow)
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CORRELATION OF THE PERMIAN OF OREGON

Any correlation based on a single group of animals, unless that group is an accepted standard of comparison, must be regarded as tentative. In view of the fact that goniatites and fusulines at present are regarded as the most reliable groups in the Permian, some conflict with a correlation based on brachiopods alone may be expected. The brachiopods of the upper Paleozoic are still too little known for all the superfamilies represented to be reliable. Furthermore, some of the genera such as *Composita* have few morphological characters on the exterior and, at present, are of no value in correlation. Investigation of the interior of such brachiopods may prove them to be more useful but development of the interior will require much skill and more time than most paleontologists are willing to give.

The Permian assemblage from Oregon is a varied one but it contains a number of genera that can be excluded from consideration because of their present slight correlative value. These are *Lingula*, *Rhipidomella*, *Derbyia*, *Composita*, *Squamularia*, and *Hustedia*. In addition *Neospirifer*, *Crurithyris*, and *Punctospirifer* are added to this list, not because of any implied lack of correlative value, but because the specimens available are too poor or insufficiently represented to use.

Another special problem in this exercise in correlation is the fact that some of the genera and species are unlike any described American Permian species. Comparison with European forms, and especially Russian ones, is difficult because comparative material does not exist in this country. Furthermore the modern illustrations of some of the

Russian species are not good, and the good available pictures, those of Tschernyschew, are often provided with a stratigraphic assignment of dubious value.

DISCUSSION OF THE SPECIES

Meekella in the Oregon fauna appears to have little value in correlating these rocks. The species represented is unlike any of the European species but is most like *M. striatocostata* (Cox) from the Wolfcampian in Kansas. It also resembles *M. difficilis* Girty from the Bone Spring and Leonard formations of Texas and *M. skenoides* Girty from the Word and Delaware Mountain formations of Texas.

Of the two species of *Chonetes* in the Oregon fauna, one is like *C. timanicus* of the *Schwagerina* zone of the Timan, and the other, the larger of the two, is most like three Word species: *C. deliciasensis* King, *C. monosensis* Cooper, and *C. phosphoriensis* Branson. The indication is thus of a post-Leonardian age. The fragmentary *Chonetinella* is not of much help because it cannot be related to known species. The last chonetid from Oregon is *Paeckelmannia* cf. *C. alatus* Stuckenbergh which has no known counterpart in American described species but is reported from the Artinskian of the Urals.

The one species of *Leptodus?* from Oregon is an equivocal form. Comparison with numerous specimens in the National Museum collection suggests that it is most related to some of the small subconical forms common in the upper part of the Leonard formation of the Glass Mountains. These are undescribed; consequently, nothing definitive about the relationships of the Oregon species can be stated.

The productoids in the Oregon fauna are a numerous and varied group. They also contain a number of genera and species that have considerable value in correlation. Some uncertainty, however, exists in the stratigraphic assignments of some of the Russian species. In general, the present assigned stratigraphic levels of these are far lower than similar species in North America.

Avonia oregonensis Cooper, n. sp., is similar to *A. tuberculatus* (Moeller) from the "*Schwagerina*" horizon in Russia. In North America *A. subhorrida* (Meek) from the Phosphoria formation appears to be a related species. Other related species occur in the Word formation, and similar forms appear in the Leonard but the latter are smaller and probably unrelated. They do, however, indicate that the genus has a fairly long range.

Two species of *Antiquatonia* occur in the Oregon fauna. This genus is not yet well known in North America but indications in the

collections of the National Museum are that it ranges through much of the Pennsylvanian and into the Permian. The Oregon specimens are related to *A. hessensis* (King) from the upper Leonard of the Glass Mountains.

A number of Oregon specimens are referred to two species of *Alexenia*, a genus described in Russia. This genus embraces shells like the familiar "*Marginifera*" *lasallensis* of the American Pennsylvanian and Permian. The generic assignment is not entirely a happy one because the interior of the American shells does not agree well with the published diagram of the interior of the type species. Nevertheless, the American shells are long ranged and seem to embrace the Oregon specimens. The genus in America goes to lower Word. The Oregon specimens are not especially distinctive.

Two species of *Kochiproductus* are recognized in the Oregon fauna, one of them new but the other assigned to the Russian species *K. porrectus* (Kutorga) from the *Cora* and "*Schwagerina*" beds of Timan and the Urals. This genus in North America is common in the Wolfcampian but is rare above. A species occurs in the Bone Spring formation but it is not yet known from the Word or higher beds. In Greenland, however, *Kochiproductus* occurs in the late Permian. It does not therefore give definitive aid in correlation but it is definitely in the "*Schwagerina*" beds of Tschernyschew.

For correlation one of the best species in the Oregon fauna is *Muirwoodia transversa* Cooper, n. sp. In North America this genus is not known below the Word formation. It appears in the Lower Word in great abundance and is common in a larger form in the Phosphoria formation and its equivalents in Nevada, Utah, Wyoming, and Mexico. The genus is also known in Greenland. In Russia, however, it may have a longer range than in North America. It is recorded there from the "*Schwagerina*" horizon and is known from the Jisu Honguer limestone in Mongolia and elsewhere in China.

At one time *Waagenoconcha* was regarded as an excellent guide to the Permian, but now it is known from the Pennsylvanian of this country and occurs in pre-Permian rocks in Russia. The Oregon species is a small one but is like small individuals of *W. montpelierensis* Girty.

Krotovia is represented by three species, one of them new. Of the previously described species, *K. aff. K. barenzi* is from the "*Schwagerina*" beds in Russia and from the Upper Marine group in northeast Greenland. *Krotovia pustulata* (Keyserling) is from the "*Schwagerina*" beds of Russia and the Mapping limestone of China. In North America no other described Permian productoid like this one is known.

One species is referred to *Pleurohorridonia* with a query. This genus was recently described by Dunbar from Greenland and is assigned to late Permian. The Oregon specimen is too poor and uncertainly identified to use in correlation.

One species is referred to *Linoproductus lutekewitschi* which is not definitely located stratigraphically but comes from the *Productus* beds in Greenland.

Anidanthus is a distinctive linoproductid known from Russia, North America, and Australia. In North America it is abundant at the top of the Leonard and the base of the Word formations. A Russian species *A. aagardi*, which is similar to the Oregon species, is known from the "*Schwagerina*" beds and the Artinskian.

Echinoconchus inexpectatus Cooper, n. sp., is most like *E. fasciatus* (Kutorga) which occurs in the "*Schwagerina*" limestone of Russia. In the United States outside Oregon *Echinoconchus* is an exceedingly rare fossil in the Permian.

Marginifera is so uncertainly identified in the Oregon fauna that it cannot be used in correlation. The new genus *Probolionia* has a structure like that of the Mississippian genus *Diaphragmus* and cannot be evaluated in correlation at the present time.

The pretty little shell here referred to *Proboscidella*(?) is like *P.?* *kutorgae* from the "*Schwagerina*" beds of Russia but unlike any known American productoid.

The Rhynchonellacea are not well represented in the Oregon fauna. The one *Wellerella* is like *W. pinguis* (Girty) from the Leonard and Word and *W. shumardiana* (Girty) from the Capitan limestone. *Rhynchopora magna* is so close to other rhynchoporas and the range of the genus is so long that it has little value in correlation.

The Stenoscismatacea are common in Oregon and give close ties with Russia. Several species of *Stenoscisma* are all close to Russian forms from the "*Schwagerina*" beds.

Cleiothyridina is rare in the Permian of North America. A species of small size is known from the Wolfcamp formation of the Glass Mountains. *Cleiothyridina gerardi* (Diener) to which one Oregon species is referred is a member of the fauna of the "*Schwagerina*" beds. *Pseudomartinia berthiaumei* is closest to species from the "*Schwagerina*" beds of Russia.

Spiriferella draschei (Toula) is a Russian species identified in Oregon which belongs in the "*Schwagerina*" beds and the Artinskian. It has also been identified in the Cache Creek series of British Columbia.

Spiriferellina pauciplicata Cooper, n. sp., from Oregon is most like

S. pyramidata (Tschernyschew) which occurs in the Russian "*Schwagerina*" beds.

Rostranteris is a little-known terebratuloid genus described from Sicily where it is said to be Word in age (Miller, 1933). The Oregon species, *R. merriami* Cooper, n. sp., is most like *Rhynchonella keyserlingi* Moeller from the "*Schwagerina*" beds of Russia. The other Oregon species, *R. sulcatum* Cooper, n. sp., is most like *R. nucleola* (Kutorga) also from the "*Schwagerina*" beds but identified widely in other formations throughout the world.

Of the three species of *Dielasma* described from the Oregon fauna, *D. ? truncatum* Cooper, n. sp., is eliminated from consideration because of the uncertainty of its stratigraphic position. The other two species, both new, are not very distinctive. *Dielasma breviplicatum* Cooper, n. sp., is most like *D. prolongatum* Girty from the Delaware Mountain formation.

CORRELATION OF THE OREGON FAUNA WITH PERMIAN FAUNAS OF NORTH AMERICA

It is difficult to correlate Permian faunas on the basis of brachiopods because little is known about them. In North America only three studies are available for consultation: Girty's (1909) report on the Guadalupian fauna of west Texas, which, although massive, is incomplete; King's (1930) report on the Glass Mountains, Texas, brachiopods; and Dunbar and Condra (1932) on the Pennsylvanian brachiopods of Nebraska. The title of the last monograph is misleading because the report contains descriptions of many Lower Permian species.

Inspection of the Oregon fauna will at once show its Middle Permian affinities. It is therefore unnecessary to consider Wolfcampian or the higher Guadalupian. In comparing with the Glass Mountains sequence, in which the brachiopods are perhaps better known than in any other fauna, it is necessary to make an explanation of the Leonard and Word formations.

Glass Mountains.—The Leonard fauna is a varied one. The assemblage at the base and for some hundreds of feet is characterized by *Scacchinella* and is quite different from the fauna found in the upper part. The fauna of the Leonard described by King in 1930 is characterized by a number of genera which, in the Glass Mountains, are confined to this interval: *Institella* and *Uncinuloides*. In the eastern part of the mountains the Word formation overlying the Leonard is distinguished by the bituminous and laminated nature of

the limestones. These limestones are exactly like the Bone Spring limestone of the Guadalupe Mountains. Furthermore, some of the fossils of the Lower Word (limestone No. 1) are those of the underlying Leonard: *Dictyoclostus bassi* and *Perrinites*, a goniatite.

According to A. K. Miller (1945, p. 14) *Perrinites* characterizes the Leonard but the Lower Word is actually also in the zone of *Perrinites*. Furthermore, a few brachiopods that appear first in Word limestone No. 1 are prophetic of the higher Word. The most important one of these is *Muirwoodia*, which has not yet been seen in the Leonard. Chiefly on the basis of the presence of *Muirwoodia* the Oregon Permian seems to ally itself with the Word limestone No. 1. No other brachiopod species or genera in the Oregon Permian are violently in conflict with this notion.

A correlation of the Oregon Permian with the lower Word also suggests alliance of the fauna with that of the Phosphoria of Idaho where *Muirwoodia* is also present, together with other species that are in line with this correlation. The Monos formation of Mexico has been allied with the Phosphoria, but it seems to have affinities rather with the middle or upper Word than with the lower part.

British Columbia.—The Cache Creek formation of British Columbia has long been known to be of Permian age. Parts of it have been correlated with Wolfcampian and Leonardian (Thompson and Verville, 1950) but still younger Permian, the Guadalupian, has also been recognized (Thompson, Wheeler, and Danner, 1950). Kindle (1926) described a species of *Leptodus* from this formation in British Columbia, and Girty (*in Daly* 1915, pp. 121-122) listed some Russian species that are the same as some listed herein. However, the formation or series was dated as Pennsylvanian rather than Permian.

Crockford and Warren (1935) published a list of fossils from the Cache Creek series which includes names similar to or identical with those recorded in Oregon. These authors indicate the Eurasiatic affinities of the fauna and the slight resemblance to the faunas of the Glass Mountains and the Phosphoria. They did not, however, offer a specific correlation.

It seems safe to say that the Oregon fauna is represented in the Cache Creek series, not in the lower or Wolfcampian part but in post-Wolfcampian beds. The fossils listed by Crockford and Warren came from the upper part of the series, and it is to this part that the Oregon fauna is related.

CORRELATION OF THE OREGON FAUNA WITH THE PERMIAN FAUNA
OF RUSSIA

The Permian fauna of Oregon has obvious and close affinity to the fauna of part of the Russian Permian sequence. The published Russian work which illustrates these fossils best is that by Tschernyschew (1902), especially the species described from the Ufa Plateau. Unfortunately, these are not adequately located stratigraphically.

Tschernyschew described brachiopods from two regions in his great monograph: From the Timan arch in northeastern Russia and the Ufa Plateau in southeastern Russia. According to Dunbar (1940) Tschernyschew established a sequence in the Timan area consisting of the *Omphalotrochus* beds, *Cora* beds, and *Schwagerina* beds in ascending order. In attempting to apply this sequence to the strata of the Ufa Plateau far to the south, Tschernyschew made some mistakes. The fossils he used for correlation purposes were not his zone guides, the fusulines, but the brachiopods which accompany them. Consequently, in the Ufa Plateau with its reefy developments, facies fossils were mistaken for guide fossils with the result that the *Schwagerina* zone was identified far above its true position. The "*Schwagerina*" zone of the Ufa Plateau region thus contains brachiopods that do not occur in the true *Schwagerina* zone.

Lately the "*Schwagerina*" zone of the Ufa Plateau has been divided into four formations in ascending order: Chernya Rechka, Irghina, Sarga, and Krasnoufinsk formations. These make up the Artinskian in this region (Tolstikhina, 1935). Lists of species from these formations are given by Fredericks (1934), Gorsky (1937), and Tolstikhina (1937). Most of the Russian species identified in the Oregon Permian and other closely related forms range throughout these formations. These Russian species are *Kochiproductus porrectus* (Kutorga), *Krotovia pustulata* (Keyserling), *Stenosisma mutabile* Tschernyschew, *Cleiothyridina gerardi* (Diener), *Squamularia rostrata* (Kutorga), and *Spiriferella draschei* (Toula).

These Russian species therefore permit correlation with the Artinskian. It is more difficult to delimit the part of the Artinskian represented in Oregon. The Chernya Rechka formation can be eliminated from consideration because it contains *Scacchinella* and other fossils indicating a late Wolfcampian or early Leonardian age. The Oregon fauna thus seems best to conform with the Irghina and Sarga faunas and is thus correlative to medial or late Artinskian.

Study of the Permian brachiopod fauna thus indicates that corre-

lation in the United States is with the fauna of the basal Word which contains the Leonardian elements *Perrinites* and *Dictyoclostus bassi*. In Russia the correlation is with medial to late Artinskian.

Another and perhaps more positive correlation will be afforded by study of the fusulines which are common in the Permian rocks of the Grindstone-Twelvemile Creeks area. It is possible, however, that the correlation based on the fusulines will be at variance with the present one derived from study of the brachiopods. Correlations based on a single group of animals are seldom reliable unless the animal group used is an already established zone fossil. Zoning of the late Paleozoic has hitherto been based on the fusulines. The brachiopods of the Pennsylvanian and Permian, however, are still too poorly known to be reliable as zone fossils. They will increase in correlative value as more collections and critical studies are made.

DESCRIPTION OF THE SPECIES

In the descriptions full synonymies are not cited. Citation to the original description is generally given. This is followed by one or more references where full synonymies appear.

Class GASTROCAULIA

Superfamily OBOLACEA Schuchert, 1896

Family OBOLIDAE King, 1846

LINGULA sp.

Plate 1A, figures 1-3

Shell small for the genus, length twice the width, strongly convex in anterior and posterior profile but slightly convex in lateral profile. Beak bluntly pointed; sides gently rounded but anterior margin narrowly rounded. Interior with a long ridge extending along the axis of the valve nearly from the beak to about the middle where it ends at a callus swelling on the floor. Traces of two pallial trunks appear anterior to the callus.

Measurements in mm.—Length 17.3, width at middle 8.8.

Types.—Figured specimens, U.S.N.M. 125311, 12531.

Localities.—S50; U.O. 2204-3.

Discussion.—*Lingula* is rare in any Permian rocks in the United States and is apparently not frequently met elsewhere. This is a more elongated and more acutely pointed species than *L. carbonaria exprorecta* Girty from the Phosphoria formation in Wyoming. The material available is not sufficient for the establishment of a species, as it consists only of a pedicle valve and a crushed brachial valve.

Class PYGOCAULIA

Suborder DALMANELLOIDEA Moore, 1952

Superfamily DALMANELLACEA Schuchert and Cooper, 1931

RHIPIDOMELLA sp. 1

Plate 1F, figure 12

This genus is represented by a single specimen, a small brachial valve having a length of 5.6 mm. and a width at the widest point, slightly anterior to the middle, of 5.4 mm. Anterior profile somewhat strongly convex and slightly narrowed in the median region. Lateral profile most convex in the umbonal region and becoming less convex anteriorly. Lateral margins broadly rounded; anterior margin broadly rounded; posterior margin somewhat narrowly rounded. Beak small, protruding slightly posterior to the posterior margin. Median region marked by a faint sulcus. Costellae narrowly rounded, about 4 to the millimeter at the front margin.

Type.—Figured specimen, U.S.N.M. 125314.

Locality.—S101.

Discussion.—This is obviously a juvenile specimen and is thus difficult to relate to any of the known species from Russia or the United States.

Suborder STROPHOMENOIDEA Maillieux, 1932

Superfamily ORTHOTETACEA Williams, 1956

Family ORTHOTETIDAE MacEwan, 1939

DERBYIA sp. 1

A single imperfect brachial valve is the only representative of the large Derbyias usually so common in the Permian. It is 48 mm. long and more than 60 mm. wide. The lateral profile has moderate convexity. These measurements thus indicate a large species but no specific characters of significance can be determined.

Type.—Described specimen, U.S.N.M. 125532.

Localities.—S101, S103.

DERBYIA sp. 2

Plate 1B, figures 4-7

About medium size for the genus, wider than long, semiconical in outline. Sides rounded; anterior margin broadly rounded. Surface costellate, costellae numbering 2 to 3 to the millimeter at the front margin.

Pedicle valve with uneven lateral profile, flattened in the umbonal region, but gently convex in the anterior region; anterior profile broadly convex but with steep lateral margins. Interarea moderately long, triangular; pseudodeltidium narrow and strongly convex; palintrope steeply apsacline. Sides of interarea forming an angle of about 110° . Median septum, short, off-center.

Brachial valve evenly and moderately convex in lateral profile; anterior profile broadly convex but with a narrow median depression. Lateral slopes moderately steep. Umbo somewhat swollen; sulcus originating at the beak narrow and shallow to the front margin. Cardinal process moderately long.

Types.—Figured specimens, U.S.N.M. 125312, 125315.

Localities.—S68, S101; U.O. 2204-3.

Discussion.—The specimens assigned here are poorly preserved. They suggest an undescribed species from the upper Leonard of the Glass Mountains, Texas, but may be the young of *Derbyia* sp. 1 above.

MEEKELLA sp. 1

Plate 1D, figure 9

This genus is represented by a single specimen broken nearly through the middle but preserving the dental plates and most of the pseudodeltidium. The specimen represents a small species about 19 mm. long, about the same in width, and having a thickness of about 18 mm. Width of hinge 15 mm. The beak is erect and the interarea shows only slight curvature. The surface was marked by about 14 plications. The brachial valve is thickest posteriorly, and its beak is strongly incurved as is usual in the genus.

Type.—Figured specimen, U.S.N.M. 125313.

Locality.—637.

Discussion.—None of the Russian meekellas is like this one. *Meekella eximia* (Eichwald) is larger and more strongly plicated; *Meekella uncitoides* Tschernyschew is not strongly plicated and is a much more elongated species. Specimens figured by Tschernyschew (1902, pl. 24, figs. 7a,b) as *M. striatocostata* (Cox) are suggestive but the ribbing is more subdued. None of the Alpine species described by Schellwien (1900) even remotely resembles the Oregon species.

Compared to American Permian species the Oregon form is most like *M. striatocostata*, *M. difficilis* Girty, and *M. skenoides* Girty. These species are small compared with the generality of American meekellas. The ribbing of *M. difficilis* is similar to that of the Oregon species but is not so sharp and strongly elevated. Furthermore the

shape of the two is different, the Texas form having a more elongated and attenuated beak of the pedicle valve. In *M. skenoides* the inclination of the interarea is like that of the Oregon species but the ribbing of the Texas species is stronger and broader. Actually the American species most like the Oregon one is from the early Permian of Kansas and now called *M. striatocostata* (Cox). The latter species, which is identified in Pennsylvanian as well as Permian rocks, is in serious need of revision.

Suborder CHONETOIDEA Muir-Wood, 1955

Superfamily CHONETACEA Shrock and Twenhofel, 1953

Family CHONETIDAE Hall and Clarke, 1895

CHONETES sp. 1

Plate II, figures 27-35

Shell of about medium size for the genus, transversely subrectangular in outline; hinge narrower than the widest part which is just posterior to the middle; sides gently rounded; anterior margin broadly rounded. Surface marked by fine costellae about 4 in 1 mm. at the front margin.

Pedicle valve moderately convex in lateral profile, broadly convex in anterior profile; beak small, incurved; umbo low and only gently swollen; sulcus varying from shallow to moderately deep, extending from the umbo to the front margin; flanks moderately swollen; slopes of cardinal extremities flattened and steep.

Brachial valve gently concave; umbo deeply concave, the concavity widening anteriorly but flattening and becoming imperceptible in the anterior half. Posterolateral extremities flattened.

Measurements in mm.—Figured specimen, U.S.N.M. 125470a, length 14.6, brachial valve length 13.2, maximum width 20.9, hinge width 18.3, thickness 3.7 (this is the actual measure but the valve is exfoliated on the dorsal side; the true thickness must have been about 4.0), height 5.3; figured specimen, U.S.N.M. 125318, length 15.5, maximum width 23.1, hinge width 19.0, height 4.4?

Types.—Figured specimens, U.S.N.M. 125318, 125319, 125470a,b.

Localities.—P12; S31, S47, S68, S111; U.O. 2201-3, 2202-2.

Discussion.—This is a large species but the specimens in the collection are few and poorly preserved. Of North American described chonetids the Oregon specimens are most like *C. deliciosensis* King (1930) in the flatness of the brachial valve and the shallowness of the median sulcus of the pedicle valve, but the latter feature may be

a variable one. *Chonetes monosensis* Cooper (1953) is also suggestive because of its fine ornamentation but its brachial valve is even flatter than that of the Oregon one.

The Oregon specimens indicate a variable species or possibly more than one species. The specimen from S68 is best preserved and has both valves. The sulcus of the pedicle valve is shallow but a specimen from U.O. 2201-3 has the same form but a deep sulcus. The specimen is much exfoliated and this may emphasize the depth of the sulcus. However, a specimen from S111 is flatter and with a shallower sulcus. The description above was composed on the basis of the complete specimen, and the above comparisons were made with it.

Chonetes phosphoriensis Branson (1930) is similar internally to the Oregon species, Branson's figure 6 on plate 5 being very like the impression of the pedicle valve from S111. His species, however, appears to be more strongly costellate than the Oregon specimens.

CHONETES PYGMOIDEUS Cooper, new species

Plate 1H, figures 19-26

Shell small for the genus, subcircular in outline with maximum width at the middle, well-rounded sides and anterior margin; surface costellate, costellae numbering about 5 to the millimeter.

Pedicle valve strongly convex in lateral profile, especially in the umbonal region which is strongly swollen; anterior profile strongly and narrowly convex; median region strongly inflated; sulcus originating on the umbo, shallow but fairly broad and extending to the anterior margin; flanks not prominent; lateral slopes steep. Beak strongly incurved, overhanging the moderately long and curved interarea.

Brachial valve nearly flat in both profiles; umbonal region fairly deeply concave forming a subcircular pit under the beak; fold originating on the anterior side of the pit, low and widening moderately to the anterior margin; flanks and cardinal extremities flattened.

Measurements in mm.—Holotype, length 10.0, brachial length 7.7, maximum width 11.2, hinge width 6.7, thickness 4.9, height 5.1.

Type.—Holotype, U.S.N.M. 125469.

Locality.—S30.

Discussion.—The shape and general expression of this shell suggest an abnormal specimen, but study of it indicates that it is normal but of unusual shape for a chonetid. *Chonetes timanicus* Tschernyschew is of about the same size and shape but it is more deeply sulcate.

CHONETINELLA sp. 1

Plate 1E, figures 10, 11

Small, wider than long and with greatly extended ears; hinge forming widest part; sides sloping medially; anterior margin broadly rounded; surface marked by flattened costellae, about 5 costellae in 1 mm. at the anterior.

Pedicle valve strongly convex in lateral profile; unevenly convex in anterior profile, with narrow, rounded but sulcate median region and long, concave lateral slopes. Umbo swollen; sulcus originating on umbo, narrow and deep; flanks bounding sulcus narrowly rounded; lateral slopes concave.

Brachial valve unknown.

Measurements in mm.—U.S.N.M. 125468, length 9.6, midwidth 14.7?, hinge width (based on half measure) 17.6, height 3.7.

Type.—Figured specimen, U.S.N.M. 125468.

Locality.—S103.

Discussion.—Like the other chonetids in the collection this one is poorly preserved and not complete along the anterior margin. It is very deeply sulcate and unlike any of the species figured by King (1930) from the Glass Mountains. The Oregon specimen is a much larger species than *C. victoriana* Girty from the Sierra Diablo, Texas. *Chonetes uralica* Moeller from Russia is suggestive in the young form but the adult loses the deep sulcus at the anterior.

PAECKELMANNIA aff. **CHONETES ALATUS** Stuckenberg

Plate 1C, figure 8

Chonetes alatus STUCKENBERG, Mém. Com. Géol., St. Petersburg, vol. 16, No. 1, p. 353, pl. 5, figs. 1a-b, 1898.

Shell small with the width about $3\frac{1}{2}$ times the length; cardinal extremities acute, mucronate; hinge forming the greatest shell width. Lateral margins sloping inward; anterior margin gently curved. Strongly convex in lateral profile; anterior profile broadly convex, most convex in median region with sides gently concave. Surface smooth. Interior of pedicle valve, when the shell is moistened, with a thin, short median septum. Two spine bases visible on the hinge.

Measurements in mm.—Length 3.8, width 13.2, height 0.5.

Type.—Figured specimen, U.S.N.M. 125316.

Locality.—S41.

Discussion.—The specimen described above is very suggestive of one figured by Tschernyschew (1902, pl. 56, fig. 8), an impression of the interior. This specimen, although larger than the Oregon one,

is about 3 times as wide as long but the cardinal extremities are not preserved. A short and very thin median septum is visible just anterior to the beak. According to Tschernyschew his figured specimen was compared with Stuckenberg's. The Tschernyschew specimen is from the *Schwagerina* zone on the Issin-jelga River.

Suborder OLDHAMINOIDEA Williams, 1953

Superfamily OLDHAMINACEA Williams, 1953

Family OLDHAMINIDAE Schuchert and LeVene, 1929

LEPTODUS? sp. 1

Plate 1J, figures 36-39

Known from an impression of the pedicle interior which does not indicate any of the exterior details and does not show the usual form of the genus. The specimen is 28.7 mm. long by 33.7 mm. wide at the widest part which is slightly anterior to the middle. The septal apparatus is moderately simple, consisting of four lobes on each side of the median axial thickening. Axis thick, moderately elevated, bounded on each side by a narrow groove from which are given off the oblique lobes. Angle of divergence of lobes from lateral grooves 50° . Ridges between lobes thick and rounded. Troughs between the lateral ridges marked by oblique striations on the sides but by a low, rounded ridge on their floor.

Type.—Figured specimen, U.S.N.M. 125325.

Locality.—637.

Discussion.—The specimen on which the foregoing description is based is an impression of the interior of the pedicle valve prepared by removing much of the shell from the grooves. Not sufficient of the specimen is preserved to make an accurate generic or specific determination. It is referred to *Leptodus*, but without information on the exterior, especially the posterior attachment surface, the determination cannot be regarded as positive. The specimen is suggestive of some of the small stout leptodids from the upper part of the Leonard formation in the Glass Mountains but these have not been described.

The Oregon example is quite unlike the specimen from the Cache Creek fauna of British Columbia described by Kindle (1926). The Canadian specimen has the grooves nearly parallel and nearly at right angles to the axis of the shell, whereas the Oregon specimen has the grooves directed anterolaterally.

Suborder PRODUCTOIDEA Maillieux, 1940

Superfamily PRODUCTACEA Waagen, 1883

Family PRODUCTIDAE Gray, 1840

PROBOLIONIA Cooper, new genus

Shells usually of small or medium size, subrectangular; hinge wide, usually equal to width at middle or wider; ears prominent, acute or forming a right angle; surface costellate but with visceral disk also rugose and usually strongly reticulate; spines few in number, generally 6 large spines: 1 on each ear, 1 on each flank just above the ear, and 1 on the trail near the sulcus midway between the point of geniculation and the front margin. Additional spines present as shown by scattered bases but not forming a definable pattern.

Pedicle valve with reticulated visceral disk, strong sulcus and well-rounded flanks; interior with crenulated ridge bounding inner side of ear; adductor scars elevated on an elongated platform. Diductor scars broad and flabellate.

Brachial valve concave with strongly reticulate visceral disk, and with median fold corresponding to sulcus of pedicle valve; cardinal process small, bilobed on ventral face, sessile, trilobed on posterior face and surrounded on the dorsal side by a low collar; lateral ridge strong; brachial ridges narrow and strongly thickened; visceral disk anterior extended anteroventrally to form a strong shelf or diaphragm from ear to ear; diaphragm forming interior edge of successive trails, several of which may be preserved. Brevisseptum short and slender.

Type species.—*Probolionia posteroreticulata* Cooper, new species.

Discussion.—This genus is characterized by its elongate form, strong costellae and strongly reticulate visceral disk, paucispinose exterior, and the extreme development of the marginal rim or diaphragm. The development of the rim and the successive trails connected with it are much like the same features in the Mississippian genus *Diaphragmus* (text fig. 2D).

The one described genus having greatest similarity to *Probolionia* is *Kozlowskia*. In this genus the spines of the exterior are arranged like those of the Oregon shell but *Kozlowskia* is not deeply sulcate and the costellae are never clearly in relief nor as conspicuous as they are in the Oregon shell. Furthermore, *Kozlowskia* is not so strongly geniculated and does not have a strongly reticulated visceral disk. The interiors of both valves of *Kozlowskia* are similar to the interior of *Probolionia* but a strong difference in the marginal shelf

is apparent, that of the Oregon genus being much more strongly developed.

The external ornamentation of *Marginifera* with its strong costellae on a long trail, strongly sulcate trail, and rugose visceral disk is like that of *Probolionia*. A major difference on the exterior appears in the strong row of spines on the flanks of *Marginifera* which extend from the anterior margin nearly to the beak and overhang the naked ears. On the inside another difference between the two genera is apparent. The marginal shelf in *Marginifera* is an overhanging ledge as it is in *Probolionia* but it does not bear a series of trails as in the Oregon genus (text fig. 2C). The shelf in *Marginifera* appears to have been built out from the visceral disk but no additional trail added; the shelf thus forms a ledge over the trail rather than being the trail attachment of the brachial valve.

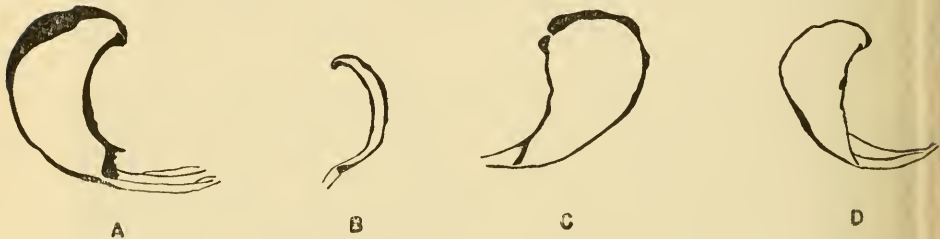


FIG. 2.—Longitudinal sections of productoid genera.

- A. *Probolionia posteroreticulata* Cooper, new species. Longitudinal section showing the diaphragm and numerous trails of the pedicle valve, $\times 2$, paratype, U.S.N.M. 125366e. Compare with figures C and D. Locality S103.
- B. *Proboscidella? carinata* Muir-Wood and Cooper, new species. Longitudinal section showing the thickened subperipheral rim on the pedicle valve, $\times 2.5$, hypotype, U.S.N.M. 126981a. Locality 2204-1.
- C. *Marginifera typica* Waagen. Longitudinal section showing margin on brachial valve and lack of trails on exterior of that valve, $\times 2$, hypotype, U.S.N.M. 124032b. Permian, $\frac{1}{4}$ mile southeast of Fazawadi Dhok, above Warcha Mandi, Salt Range, Pakistan.
- D. *Diaphragmus cestriensis* (Worthen). Longitudinal section showing diaphragm and trails on brachial valve, $\times 2.25$, hypotype, U.S.N.M. 124040. Fayetteville formation $\frac{1}{2}$ mile south of Glendale School, just east of east line of sec. 20, T. 15 N., R. 20 E., Muskogee County, Oklahoma.

No other genus having a shelf in the brachial valve like *Marginifera* appears to be related to the Oregon genus more than in a family relationship. *Eomarginifera* has spines like *Probolionia* but the ornamentation and marginal ridge are quite different. *Spinomarginifera* has a different arrangement to the spines, and *Paramarginifera* is differently ornamented, is transverse, and has a strong marginal ridge in the pedicle valve.

PROBOLIONIA ELONGATA Cooper, new species

Plate 8B, figures 6-12

Shell fairly large for the genus, longer than wide with a short body and long trail. Width of hinge about equal to half the length of an adult; lateral margins slightly rounded; front margin broadly rounded to nearly straight. Body marked by fine, rounded costellae and concentric undulations that are cancellated by the costellae on the visceral disk; trail marked by longitudinal costellae. Entire surface covered by fine concentric growth lines.

Pedicle valve having visceral region about 10 mm. long where the valve geniculates at about 90° . Geniculated part of trail continued for a distance nearly twice that of the length of the visceral part and strongly convex in lateral profile. Sulcus originating at about 5 mm. from the beak and extending to the front margin, deepest on the geniculated portion of the valve and becoming somewhat shallower anteriorly; in section or profile the sulcus makes a broad U with narrowly rounded rather than sharp trough. Beak and umbo somewhat elongated, moderately convex; visceral region moderately inflated and with steep lateral slopes. Cardinal extremities auriculate; ears forming a right angle in the adult, acute in the young. Areas bounding sulcus on body and trail rounded and with steep lateral slopes.

Brachial valve short and moderately concave, with a concave umbonal region and moderately concave flanks bounding a short, low fold that originates at about the middle of the visceral area. Cardinal extremities flattened. Visceral region strongly and coarsely reticulated. Flange well-developed.

Interior of brachial valve with long and prominent flange around the margin of the visceral disk and with the trail given off from the flange at an acute angle. Inner flange or margin about 2 mm. in length.

Measurements in mm.—Holotype, total surface length of pedicle valve 37.2, length 21.2, length of visceral region 9.2, length from geniculated part to front margin measured on surface 28, hinge width 20, width 20, height 13; paratype, U.S.N.M. 125372, total surface length 41, length 23.0, length of visceral region 10, length from geniculation to front margin 31, hinge width 20.6, width 19, height 17.

Types.—Holotype, U.S.N.M. 125371a; figured paratype, U.S.N.M. 125372; unfigured paratype, U.S.N.M. 125371b.

Localities.—S46, S49, S68; U.O. 2202-3, 2204-3.

Discussion.—This species is the largest of the marginiferids found in the Oregon Permian. Besides this feature it has a strongly convex

visceral disk region, a deep sulcus, and strongly rounded flanks. It differs from *M. posteroreticulata*, new species, in size, in being shallower, and in having a less strongly reticulate visceral disk. This species is uncommon in the Oregon section.

PROBOLIONIA POSTERORETICULATA Cooper, new species

Plate 7A, figures 1-23; text figure 2A

Shell of about medium size for the genus, with length and width about equal; sides gently rounded and sloping gently toward the valve middle; anterior margin gently rounded to straight. Visceral region of both valves coarsely reticulate; trail marked by closely crowded costellae. Spines forming a horizontal row of 4 near middle, 1 on flank near ear and 1 on flank near sulcus.

Pedicle valve with visceral region occupying about one-third the surface length, strongly reticulated and gently convex in lateral profile; geniculation strong; trail long, moderately convex in lateral profile. Sulcus originating 4 or 5 mm. anterior to the beak, narrow and moderately deep throughout its extent to the front margin. Flanks bounding sulcus narrowly rounded and with steep lateral slopes. Beak small; umbo narrow and gently swollen.

Brachial valve with visceral region strongly and coarsely reticulated; valve short, moderately deep, marked medianly by an obscure, low fold. Inner flange long and prominent.

Measurements in mm.

	Surface length	Length	Hinge width	Width	Height	Thickness	Length visceral disk
Holotype	23.0	12.4	15.2	12.9	7.6	~	8.0
Paratype (125366b)	24.0	13.2	14.1	13.6	8.0	?	7.5
" (125366c)	24.0	13.7	17.6	14.6	10.0?	?	?
" (125369)	25.0	14.6	16.4	14.3	9.8	?	9.0
" (125374)	22.0+	13.2+	?	13.5	?	5.3	7.0
" (125367)	24.5	14.4	14.6	13.4	8.7	?	6.5

Types.—Holotype, U.S.N.M. 125369; figured paratypes, U.S.N.M. 125366a-f,j, 125367, 125374, 125550; unfigured paratypes, U.S.N.M. 125366g-i, 125375, 125455.

Localities.—638; P10; S12, S29, S30, S40, S46, S49, S69, S87, S103, S106; U.O. 2201-4, 2202-2, 2202-5, 2216-1.

Discussion.—This is the most common marginiferoid in the Oregon Permian, being most abundant at S103. The species is characterized

by a strongly reticulate visceral disk, the deep sulcus originating just anterior to the visceral disk, and a long, prominent flange around the margin of the visceral disk. This species cannot be confused with the much larger *P. elongata*, new species, and differs from the other smaller, described marginiferas in having an inner flange in the brachial valve.

Family DICTYOCLOSTIDAE Stehli, 1954

Subfamily DICTYOCLOSTINAE Stehli, 1954

AVONIA OREGONENSIS Cooper, new species

Plate 2C, figures 13-24

Shell large for the genus, subquadrate in outline with the width slightly exceeding the length; cardinal extremities nearly a right angle; lateral margins gently rounded; anterior margin broadly rounded.

Pedicle valve strongly convex with a strongly incurved beak and strongly convex umbo. Outline of umbonal region forming approximately a right angle. Median region inflated, with very steep slopes to the margins. Sulcus shallow, originating just anterior to the umbo, poorly defined, not always reaching the anterior margin. Hinge just slightly narrower than the maximum shell width which is located at about the middle. Ears ill defined. Surface marked by scattered pustules bearing long, slender spines; pustules continued into more or less long, rounded radial ridges most numerous and longest anteriorly.

Brachial valve about 20 percent shorter than the pedicle valve, and having a decidedly rectangular outline, strongly convex in profile, thus producing a thin visceral cavity; umbo deeply concave; fold poorly defined, anterior to umbo and extending to the front margin; areas bounding fold deeply concave with the greatest concavity located at about the middle; ears well defined, deflected toward the pedicle valve and slightly concave. Surface marked by irregularly arranged, shallow, elongate pits corresponding to the spine-bearing pustules of the pedicle valve.

Measurements in mm.—Holotype, length 24.6, width 29.1, thickness at middle 3.7, height from margin to point of maximum convexity of pedicle valve 15.2, surface measure 40+, length of brachial valve 20; paratype, U.S.N.M. 125322, length 19.0, width 25.4, thickness at middle 3.7, height 9.7, surface measure 30+, length of brachial valve 15.6.

Types.—Holotype, U.S.N.M. 125323a; figured paratypes, U.S.

N.M. 125321a,b, 125322, 125323b, 125324; unfigured paratypes, U.S.N.M. 125320a,b.

Localities.—636; L8, L23; S12, S14, S30, S40, S43, S45, S46, S49, S87, S103, S106; U.O. 2201-2, 2202-2, 2202-3, 2202-5, 2202-6, 2204-1, 2204-3.

Discussion.—This species is characterized by its large size and its surface covered by elongate, distant pustules or spine ridges. It is most suggestive of *Productus tuberculatus* Moeller but differs in having an obscure median sulcus on the pedicle valve rather than a distinct and fairly deep one as on the Russian species. Furthermore, the spine bases of the American species are more elongated than those of the Russian species and are somewhat more abundant. This species is fairly common in the Oregon Permian.

Productus subhorridus Meek is an American form that may be related but it differs markedly in form, profile, and the arrangement of the spines. This stock of productoids appears in the early Permian, is common in the Leonard, and reaches a large size in the Word.

KROTOVIA aff. K. BARENZI (Miloradovitch)

Plate 10C, figures 12-17

Krotovia barenzi MILORADOVITCH, Trans. Arctic Inst., vol. 37, p. 139, pl. 5, fig. 12, 1935; BRANSON, Geol. Soc. Amer. Mem. 26, p. 378, 1948.

Material poorly preserved and consisting of several pedicle valves; small, length and width nearly equal, outline suboval; lateral margins gently rounded, anterior margin broadly rounded; hinge slightly narrower than the maximum width which is near the middle. Lateral profile strongly convex; anterior and posterior profiles narrowly domed. Beak narrow and incurved, protruding beyond the posterior margin. Umbo swollen. Surface ornamented by distant growth varices and small closely crowded spines covering all parts of the pedicle valve.

Measurements in mm.—Figured specimen, U.S.N.M. 125336b, length 16.2, width 15+, hinge width 12.9, surface measure 27.5; figured specimen, U.S.N.M. 125336a, length 13.2, width 11.6, hinge width ?, surface measure 22.

Types.—Figured specimens, U.S.N.M. 125336a,b.

Locality.—S101.

Discussion.—This species is characterized by its small size and elongate form. The specimens closely resemble those figured by Tschernyschew (1902, pl. 30, fig. 8).

KROTOVIA PARVA Cooper, new species

Plate 2B, figures 5-12

Shell small, about one-third wider than long; lateral margins narrowly rounded, anterior margin broadly rounded; cardinal extremities nearly a right angle. Surface covered by small, fairly densely crowded spines that arise from short, low pustules.

Pedicle valve strongly convex in lateral profile with the greatest convexity at about the middle; anterior profile strongly convex in the midregion but with the sides inclined. Beak strongly incurved over the hinge; umbo narrow, swollen, and with steep slopes to the hinge and cardinal extremities. Midregion of valve swollen, with steep lateral slopes but the anterior slope somewhat less steep.

Brachial valve concave with the deepest part in the median region and posterior to the umbonal region. Cardinal extremities slightly flattened.

Measurements in mm.—Holotype, length 10.9, surface length 11, width at middle 14.5, hinge width 12.0, height 5.6?; paratype, U.S. N.M. 125355b (brachial valve), length 88, midwidth 12.6, hinge width 11.8.

Types.—Holotype (pedicle valve), U.S.N.M. 125355a; figured paratype, U.S.N.M. 125465; unfigured paratype (impression of brachial exterior), U.S.N.M. 125355b.

Localities.—P10; S40.

Discussion.—This species is characterized by its small size, transverse outline, and numerous fine spines. Its transverse form and numerous spines distinguish it from *K. barenzi* (Miloradovitch) from Russia and Greenland. No American species is like it in size or ornamentation. It differs from *K. pustulata* young in its finer spines. This species is also suggestive of *K. nielsoni* Dunbar, but the Greenland species, although nearly of the same size as the Oregon species, is a much rounder form in outline and thus much less transverse.

KROTOVIA PUSTULATA (Keyserling)

Plate 8A, figures 1-5

Productus pustulata Keyserling, TSCHERNYSCHEW, Mém. Com. Géol., St. Petersburg, vol. 16, No. 2, p. 617, pl. 30, figs. 1,2; pl. 53, figs. 5,6, 1902.

Krotovia pustulata (Keyserling) BRANSON, Geol. Soc. Amer. Mem. 26, p. 379, 1948.

This species can be recognized by its large size and the peculiar arrangement of the spines on the surface. The shell is transversely subrectangular in outline with a moderately convex pedicle valve

marked anteriorly to the beak by a shallow sulcus. The brachial valve shares the curvature of the pedicle valve, thus producing a shell with only a thin body cavity. The spines of the pedicle valve are short and have a crude quincuncial arrangement. The brachial valve impression is pitted, each pit corresponding to a spine on the pedicle valve. A typical specimen (hypotype, U.S.N.M. 124021) is 28 mm. long, 41 mm. wide, and 4 mm. thick at the umbo. The height from the margins to the point of greatest curvature is about 12 mm. The specimen figured by Tschernyschew (1902, pl. 30, figs. 2a-c), has almost the same measurements as the figured Oregon specimen.

Types.—Figured hypotype, U.S.N.M. 124021.

Localities.—638; L8; P10; S40, S41, S43, S46, S56, S70, S87, S103; U.O. 2201-1, 2204-3.

ANTIQUATONIA RETICULATA Cooper, new species

Plate 3A, figures 1-9

Large, subquadrate in outline but with the width slightly greater than the length; margins not clearly preserved; somewhat more than posterior half finely reticulate; trail costellate, costellae unequal in size, narrowly rounded and separated by spaces about equal in width to the width of the costellae; costellae numbering about 4 in 5 mm. at the anterior part of the trail.

Pedicle valve unevenly convex in lateral profile, the anterior third, except for the beak and umbo, gently convex; median third narrowly convex and anterior third or trail gently convex. Beak strongly incurved but not protruding beyond the hinge line. Umbo broadly swollen and with steep lateral slopes. Sulcus originating about 10 mm. anterior to the beak, shallow at its origin but becoming deeper anteriorly where it forms a deep, broadly V-shaped trench in the trail. Flanks bounding sulcus in the visceral region moderately swollen but on the trail they are strongly swollen and have steep, rounded lateral slopes.

Brachial valve gently concave in lateral profile but with a short trail geniculated at about a right angle to the visceral region. Umbo moderately deeply sulcate. Median fold low, fairly broad but becoming nearly obsolete on the trail.

Measurements in mm.—Holotype, length 44.0, width at middle 50.4+, surface length 90, height 33.5?; brachial valve, paratype, U.S.N.M. 125349, length 36.3, width 48.1, surface length 52.

Types.—Holotype, U.S.N.M. 125348; figured paratypes, U.S.N.M. 125347, 125349.

Localities.—P10; S20, S67.

Discussion.—This species is characterized by its subquadrate form, strong convexity, strongly reticulate visceral region and strong sulcus. This species is more like *A. hessensis* than it is like its associate in the Oregon fauna. It is more convex and longer than *A. sulcatus* and is differently ornamented. It differs from *A. hessensis* in being larger, somewhat more strongly ribbed, with a larger reticulate area and more convex profile.

ANTIQUATONIA SULCATA Cooper, new species

Plate 5C, figures 18-22

Shell fairly large for the genus, wider than long with the hinge forming the widest part. Lateral margins gently rounded; anterior margin broadly rounded, emarginate medially. Slightly less than posterior half of the shell reticulate, the trail costate, the costae narrowly rounded and separated by spaces not quite equal to the costae in width, and 7 to 8 costae occupying a space of 10 mm. on the front half.

Profile of pedicle valve strongly convex with the greatest curvature slightly posterior to the middle; reticulate or visceral portion strongly convex with strongly curved beak which, however, protrudes slightly beyond the posterior margin. Umbonal region slightly convex but with steep slopes to the cardinal extremities. Sulcus originating 10 to 12 mm. anterior to the beak as a narrow groove, deepening rapidly but not materially widening in its extent to the front margin. Flanks bounding sulcus strongly rounded with steep lateral slopes to the margins; ears prominent, moderately extended, narrowly rounded in profile. Lateral slopes over ears marked by a low curving ridge bearing a row of spines; ridge variable in elevation and definition.

Brachial valve forming with the pedicle valve a moderately deep visceral chamber; visceral area nearly flat in profile but with a concave umbo and concave area in front of umbo extending for about 8 or 9 mm. anterior to the beak where the concavity changes to a low and narrow fold with gently sloping sides that extend to the front margin. Areas surrounding the sulcus on the visceral region slightly convex especially in the neighborhood of the cardinal extremities. Brachial valve geniculating about 20 mm. anterior to the beak strongly in the direction of the brachial valve. Geniculate area narrowly rounded in profile; trail very slightly convex in profile, steep; ears of brachial valve moderately long, narrowly rounded in profile, a narrow, curved groove anterior to the ear corresponding to the ridge on the slope of the pedicle valve.

Measurements in mm.—Holotype, length 34.7, width at middle 46, hinge width 44+, surface length 56, thickness through middle of visceral area 8.5, height 14.

Types.—Holotype, U.S.N.M. 125327; figured paratype, U.S.N.M. 125329.

Localities.—638; P10; S43, S46, S47, S51, S67, S103; U.O. 2202-2, 2204-3.

Discussion.—This species is characterized by its wide hinge, the big ears, and deep sulcus, although this last feature is somewhat variable. Few described species of *Antiquatonia* from the Permian are available for comparison.

Antiquatonia planumbona Stehli from the Bone Spring formation in the Sierra Diablo, Texas, is sulcate but not so deeply as the Oregon species. The Texas shell is also more finely reticulate than the Oregon species.

The holotype of *Productus hessensis* King is a poorly preserved specimen, but nevertheless shows the elevated ridge characteristic of *Antiquatonia*. It is also a sulcate form but is a larger and more finely ornamented species than *A. sulcata*.

Productus semireticulatus arcticus Whitfield is a deeply sulcate species similar to the Oregon form but it is not certain to what genus it belongs. In any case, the type as illustrated by Whitfield is a narrower species than the Oregon *Antiquatonia*.

PROBOSCIDELLA? CARINATA Muir-Wood and Cooper, new species

Plate 3B, figures 10-17; text figure 2B

Specimens rare, showing the pedicle valve only in a hard matrix; small, with the hinge forming the widest part; length less than the width. Pedicle valve with visceral area slightly wider than long. Semi-circular in lateral profile, more broadly arched in anterior profile; beak narrow, protruding posterior to the hinge; umbonal region narrowly swollen; sulcus originating about 5 mm. anterior to the beak, shallow and narrow, terminating in a trough 9 to 12 mm. (surface measure) from the beak. Visceral region marked by radiating costellae cancellated by concentric undulations. Trail moderately convex in lateral profile, separated from the visceral area by a slight peripheral depression; trail anterior to median troughlike depression nasute and carinate; flanks of trail moderately convex and descending nearly vertically from the visceral area. Trail ornamented by costellae.

Brachial valve closely fitting the concavity of the pedicle valve interior, as seen in longitudinal section, otherwise unknown.

Interior of pedicle valve unknown except for the presence of a subperipheral marginal thickening.

Measurements in mm.—Holotype, surface length 18, length 11.1, hinge width 13.0+, length of visceral area and trail about equal (9 each), height 7.0.

Types.—Holotype, U.S.N.M. 124156a; figured paratypes, U.S.N.M. 124157, 125533, 126981a; unfigured paratypes, U.S.N.M. 124156b, 126981b.

Localities.—638; S12, S49; U.O. 2201-2, 2204-1.

Discussion.—This interesting little productoid is unique among American species in having the median trough anterior to the visceral area and in having a long carinate trail. The only productoid like it is *Proboscidella? kutorgae* Tschernyschew (1902, p. 643, pl. 59, figs. 1-3) from the "Schwagerina" limestone of the Urals. The Russian species differs from the Oregon one in its larger size, finer and more abundant reticulation, and in the absence of the strong carina on the trail. Nothing at present is known of the interior of the Russian species.

PLEUROHORRIDONIA? ELONGATA Cooper, new species

Plate 7C, figures 30-33

Large, narrowly elongate; hinge slightly narrower than the width; cardinal extremities auriculate, ears small and rounded. Beak incurved but not protruding beyond the posterior margin; umbo narrow, sulcate; sulcus deep, widening and deepening anteriorly but narrow throughout the shell length. Flanks narrowly and strongly rounded; sides steep; surface smooth on the posterior third but longitudinally and irregularly costellate on the anterior two-thirds. Brachial valve unknown.

Measurements in mm.—Holotype, length 40.5, midwidth 31.4, maximum width 33.2, surface length 80, hinge width 26.6.

Type.—Holotype, U.S.N.M. 125346.

Localities.—S47, S51, S87; U.O. 2205-5.

Discussion.—This species is difficult to place, and few good specimens are available for study. The posterior or umbonal region appears to be quite smooth but the trail and steep lateral slopes have numerous longitudinal subdued ribs. These also appear in the deep and narrow sulcus. The only genus like this is the newly erected *Pleurohorridonia* of Dunbar. The Oregon specimens are not characteristic of the genus because they are much narrower and the ears of the cardinal extremities are not so extended. Unfortunately, the

brachial valve and spines of the Oregon species are not preserved; consequently, it is impossible to compare these features with Dunbar's species. The Oregon species differs from *P. scoresbyensis* Dunbar in its narrower outline, smaller ears, and narrower, deeper sulcus.

Subfamily LINOPRODUCTINAE Stehli, 1954

LINOPRODUCTUS cf. **L. LUTKEWITSCHI** (Stepanow)

Plate 6D, figures 27-29

Productus lutkewitschi STEPANOW, Leningrad State Univ., Sci. Bull., Geol.-Geogr. ser., vol. 2, p. 127, pl. 1, figs. 5a-c, 1936.

Linoproductus lutkewitschi (Stepanow) BRANSON, Geol. Soc. Amer. Mem. 26, p. 393, 1948.

Fairly large for the genus, length slightly less than the width; sides gently rounded, front margin broadly rounded as shown by the growth lamellae; costellae narrowly rounded and separated by spaces about equal to the width of the costellae; 5 or 6 costellae in 5 mm. at the valve middle.

Pedicle valve moderately convex in lateral profile, more narrowly convex in anterior profile but with the median region flattened and the sides steep. Umbo moderately swollen, beak small; median region flattened to gently concave; sides gently convex but steep. Cardinal extremities somewhat flattened, marked by a few prominent wrinkles.

Brachial valve moderately concave in both profiles; most concave in the median region. Umbo a shallow pit. Fold broad, low, indistinct and best defined near the middle. Posterolateral extremities flattened and marked by 5 or 6 prominent wrinkles which extend as indistinct concentric undulations on the concave portions of the valve.

Measurements in mm.—Figured hypotype, surface length 80+, length 56.1+, width (based on half measure) 62.8.

Types.—Figured hypotype, U.S.N.M. 125326.

Localities.—S14, S45, S49, S103, S111.

Discussion.—The inconspicuous beak of this species is its most striking feature.

ANIDANTHUS MINOR Cooper, new species

Plate 6A, figures 1-17

Shell small, length and width nearly equal; cardinal extremities forming small ears; sides nearly parallel; front margin broadly rounded. Surface costellate, with low, rounded costellae separated by spaces of about equal width to that of the costellae; 2 or 3 costellae occupying the space of 1 mm. at the front margin and 12 to 15

costellae in 5 mm. Brachial valve with concentric lamellae crowded anteriorly.

Pedicle valve with profile unequally convex, anterior half gently convex but posterior half almost semicircular. Anterior profile moderately rounded. Beak protruding over hinge; umbo somewhat swollen and the costellae cancellated by a few low rugae. Median region swollen and tumid, fold low, indistinct, and narrow, occupying the front half. Lateral slopes moderately steep.

Brachial valve moderately concave, most concave in the midregion. Interior unknown.

Measurements in mm.

	Surface length	Length	Width	Height
Holotype	30.0	15.0	17.0 ?	10.0
Paratype (125351)	26.0	15.0	14.0	10.0
Paratype (125466)	?	7.0	10.4	?

Types.—Holotype, U.S.N.M. 125361; figured paratypes, U.S.N.M. 125351, 125360, 125466, 125534, 125535.

Localities.—L8; P12; S41, S43, S46, S50, S87, S103; U.O. 2201-1, 2201-2, 2204-1, 2204-2, 2207, 2207-2, 2215-1, 2216-1.

Discussion.—No American species like *A. minor* are known. Certain small linoproductids such as *L. waagenianus* Girty are known to be generically distinct from *Anidanthus* and are thus excluded. However, one Russian species, *A. aagardi* (Toula), is similar to the Oregon species. The Russian form, however, is larger and less strongly convex than the American species. The costellae of the Oregon species are stronger than those of the Russian form.

MUIRWOODIA TRANSVERSA Cooper, new species

Plate 5A, figures 1-13

Shell fairly large, width almost twice the length; cardinal extremities acutely angular; lateral margins nearly straight but oblique; front margin bilobed. Shell strongly geniculated 16 mm. from the beak; angle of geniculation 65° to 75°. Geniculated trail slightly longer than the visceral region. Surface costellate, with about 8 costellae in the space of 5 mm. at the point of geniculation and at the front margin.

Pedicle valve with visceral region gently convex in lateral profile, geniculated area narrowly rounded; trail gently convex in profile, slightly more so than the visceral area. Sulcus originating about

3 mm. anterior to the beak, deepening gradually but with nearly parallel sides to the place of geniculation; sulcus on trail somewhat shallower and wider but very pronounced nevertheless. Flanks bounding sulcus on visceral area moderately swollen, most so at the place of geniculation; slopes of flanks long and gentle; region about cardinal extremities flattened. Trail strongly bilobed in anterior profile, with posterolateral portions nearly flat in profile. Beak small, strongly incurved.

Brachial valve fitting closely into the pedicle valve to make a narrow or thin visceral cavity; umbonal region sulcate; fold originating just anterior to the umbonal sulcus, low, somewhat narrowly rounded to subangular, strongest just before geniculation, less well defined anterior to geniculation. Flanks bounding fold gently concave. Two spines just anterior to geniculation moderately long, strongly divergent.

Measurements in mm.—Holotype, length 21.1, surface length 34+, hinge width based on half-measure 35.8+, midwidth (based on half measure) 30.8, thickness 4.9, height 13.2; paratype, U.S.N.M. 125337, length 19.2, surface length 36.5, hinge width 33+, midwidth 30.3; paratype, U.S.N.M. 125343, length 18, surface length 33+, hinge width 35+, midwidth 29.5.

Types.—Holotype, U.S.N.M. 125339; figured paratypes, U.S. N.M. 125337, 125338, 125340, 125342, 125343, 125345; unfigured paratypes, U.S.N.M. 125341, 125344.

Localities.—638; F; L8; P10; S40, S43, S46, S50, S103; U.O. 2201-2, 2202-2, 2204-3.

Discussion.—This species is characterized by its transverse outline and strong geniculation. It is smaller and more strongly geniculated than *M. multistriata* (Meek) of the Word and Phosphoria formations. It is larger and more strongly geniculated than *M. geniculata* Girty of the Park City formation. The Oregon species is similar to specimens of a *Muirwoodia* that occurs in abundance in the bituminous limestones of the lower Word formation in the Glass Mountains. The Texas species has a deep sulcus and a long trail but none of the specimens in the national collection appears to be as strongly geniculated or to have as long and prominent a trail as the Oregon species.

Of European species of *Muirwoodia* the Oregon species is most like *M. mammatus* (Keyserling) but the latter is a variable species. The specimens figured by Tschernyschew (1902, pl. 35, figs. 4 and 5) are much smaller and with a shallower sulcus than the Oregon specimens. The forms figured by Chao (1927, figs. 10-14) are

about the same size as *M. transversa* and have a similar ornamentation, but the Chinese species is not so strongly geniculated nor does it have as strong a sulcus as the American species.

Muirwoodia greenlandica Dunbar from Greenland is perhaps the nearest like the Oregon species but the extremely acute angle of geniculation separates these two species as it separates the Oregon shell from all others.

Subfamily MARGINIFERINAE Stehli, 1954

MARGINIFERA? BREVISULCATA Cooper, new species

Plate 7B, figures 24-29

Shell of about usual size for the genus, known only from the pedicle valve; length and width about equal; outline subquadrate. Sides and anterior margin gently rounded. Hinge equal to the greatest shell width. Surface with coarsely rugose visceral area with some reticulation, fine radial costellae on the trail and a few strong, radial plications. Spines few, but their pattern is difficult to determine.

Visceral region somewhat swollen, equal in length to less than half the surface length of the valve; lateral profile of visceral area nearly flat except for the narrowly convex umbo; beak incurved over hinge. Slopes to cardinal extremities fairly steep. Cardinal extremities produced into small ears having an angle of about 90° . Sulcus just barely perceptible at the anterior end of the visceral area just before the geniculated part of the valve. Angle of geniculation obtuse; trail gently convex in profile with moderately steep lateral slopes. Sulcus shallow, almost completely confined to the trail.

Measurements in mm.—Holotype, surface length 23, length 13.5, length of visceral area 9.5, width at hinge 15.5, height 13.3.

Types.—Holotype, U.S.N.M. 125363a; figured paratype, U.S.N.M. 125362; unfigured paratypes, U.S.N.M. 125363b-d.

Localities.—S30, S45, S49.

Discussion.—This species can be readily identified by its small size, short trail with sulcus confined to trail. It differs from *Proboionia posteroreticulata*, new species, in its shorter trail, less reticulate visceral disk and shallower, shorter sulcus. No details of the interior of this species are known; consequently, the generic assignment to *Marginifera* is queried. The exterior, however, is like that of all the other species described herein that are referred to *Marginifera*.

MARGINIFERA? COSTELLATA Cooper, new species

Plate 6C, figures 22-26

Shell small to medium size for the genus, transversely subrectangular in outline. Hinge forming widest part; lateral margins directed toward the valve middle, slightly convex; anterior margin broadly rounded. Surface marked by subdued, rounded costellae separated by spaces of much less width than the costellae. Visceral disk not strongly reticulated. Spines few, but 4 large ones located in a horizontal row on flanks and trail.

Pedicle valve having a visceral area about 10 mm. long, after which the valve is strongly geniculated. Trail moderately convex in profile and about $1\frac{1}{2}$ times as long as the visceral area. Beak protruding slightly posterior to the hinge; umbo somewhat swollen, narrow; visceral region inflated; umbonal slopes and slopes of flanks of visceral region moderately steep. Ears small but prominent, narrowly rounded, forming right angles; sulcus originating about 3 mm. anterior to the beak, extending to the anterior margin as a trough, deep and narrowly U-shaped in profile. Flanks narrowly rounded and with steep slopes to the margins. Four long spines, two on each side of the sulcus, given off at nearly a right angle from flanks bounding sulcus of trail and forming a horizontal row.

Brachial valve closely fitting the pedicle valve, deeply concave at the point of geniculation; umbo concave; fold originating about 3 to 4 mm. anterior to the umbo, moderately narrowly rounded; flanks moderately concave; ears deflected and flattened.

Interior.—A longitudinal section of a complete specimen gives no indication of a marginal rim.

Measurements in mm.—Holotype, surface length 28, length 13.6, length of visceral area 9, hinge width 18.6; height 10.

Types.—Holotype, U.S.N.M. 125368; figured paratype, U.S.N.M. 125370a; unfigured paratypes, U.S.N.M. 125370b-c.

Localities.—S39, S43, S46; U.O. 2202-2.

Discussion.—This species is characterized by its strong costellae and deep sulcus. It is similar to *Probolionia posteroreticulata*, new species, in exterior appearance but is wider, has a less reticulate visceral disk region, and the sulcus is broader. The interior is not definitely known and a margin was not seen, nor is it indicated on the exterior.

MARGINIFERA? MULTICOSTELLATA Cooper, new species

Plate 5B, figures 14-17

Shell of about medium size for the genus, known from the pedicle valve only. Subrectangular in outline and the visceral region occupying nearly half the surface length. Visceral region coarsely reticulated; trail strongly and evenly costellated. Costellae numbering about 7 in 5 mm. at the front margin. Sulcus originating about 5 mm. anterior to the beak, broad and shallow from point of origin to front margin. Beak small, umbo moderately swollen. Visceral region moderately convex in lateral profile; trail more convex than the visceral region in lateral profile. Flanks bounding sulcus gently swollen and with steep lateral slopes.

Measurements in mm.—Holotype, surface length 18.0, length 9.9, hinge width 15.6, midwidth 12.8, height 6.2.

Types.—Holotype, U.S.N.M. 125365.

Locality.—S46.

Discussion.—This species is characterized by its broad but shallow sulcus, short trail, wide hinge, and strong costellae. It is most like *Marginifera profundosulcata*, new species, but differs from it in having a shallower sulcus, finer costellae, and rounded flanks. The interior, however, is unknown; consequently, it could not be assigned to the new genus *Probolionia*.

MARGINIFERA? PROFUNDOSULCATA Cooper, new species

Plate 6B, figures 18-21

Shell of about usual size for the genus, subrectangular in outline; lateral margins sloping toward the valve middle; anterior margin medially emarginate; ears prominent, subalate. Visceral disk region obscurely reticulate; trail marked by low, broadly rounded costellae.

Pedicle valve with visceral region about 8 mm. long and trail about 10 mm. long; visceral region nearly flat in lateral profile; umbo narrowly swollen; umbonal slopes gentle. Trail strongly geniculated from visceral region, gently convex in lateral profile. Sulcus originating about 3 mm. anterior to the beak, narrow and deep, widening and deepening anteriorly to form a deep U-shaped trough. Flanks bounding sulcus narrowly rounded and with long, precipitous lateral slopes.

Brachial valve deeply concave; umbo forming a deep trough; median fold strong, originating about 4 mm. anterior to the beak. No diaphragm.

Measurements in mm.—Holotype, surface length 18, length 11.9, hinge width 17.9, midwidth 15.2, height 7.6; thickness of a complete specimen (U.S.N.M. 125364b) near middle 2.8.

Types.—Holotype, U.S.N.M. 125364a; unfigured paratype, U.S.N.M. 125364b.

Localities.—L8; S12, S40, S41, S49, S56; U.O. 2204-3.

Discussion.—This species is characterized by its deep and wide sulcus. It differs from all others described herein by this feature, but its interior is unknown and the generic assignment therefore is uncertain.

ALEXENIA? OCCIDENTALIS Cooper, new species

Plate 2D, figures 25-34

Shell of about medium size, slightly wider than long but with a long trail. Greatest width at middle, hinge narrow, ears strong, obtuse, flattened but not extended. Margins strongly rounded; posterior third moderately coarsely reticulate. Anterior two-thirds costellate with costellae narrowly rounded and separated by spaces nearly as wide as the costellae. Costellae numbering about 5 to the millimeter on the trail.

Lateral profile of pedicle valve strongly curved. Ears broken. Umbo narrowly but strongly swollen, with steep slopes; median region inflated. Sulcus originating 10 to 15 mm. anterior to the beak, shallow and broadly U-shaped, disappearing or becoming faintly defined anteriorly on the trail. Flanks bounding sulcus broadly inflated; lateral slopes rounded. Location of spines not clearly defined but spine bases are scattered over trail and lateral slopes.

Brachial valve gently concave, most so in the umbonal region which forms a shallow pit and in anterolateral extremities. Median region defined by a low, narrow fold originating just posterior to the middle of the visceral disk region but becoming poorly defined or obsolete anteriorly. Cardinal process moderately long, slender, with bilobed ventral face.

Measurements in mm.—Holotype, length 28.3, width at middle 32.7, surface length 54, height 14.5; paratype, U.S.N.M. 125334 (brachial valve) length 23.2, width 31.4, surface length 34, height 10.

Types.—Holotype, U.S.N.M. 125350; figured paratypes, U.S.N.M. 125334, 125335.

Localities.—614, 638, 639; F; P10, P12; S12, S30, S39, S41, S49, S50, S103; U.O. 2201-4, 2202-2, 2204-3, 2211-2.

Discussion.—This species is characterized by the finely reticulate

visceral disk and the long trail. The interior is imperfectly known because none of the Oregon species shows the marginal ridges, but one specimen, U.S.N.M. 125334, does show the cardinal process and this agrees with the interior of *Alexenia? parvispinosa* Stehli, the only described Permian species like the Oregon one.

Alexenia? occidentalis differs from the west Texas species in having a larger size, longer trail, less transverse outline, and more concave brachial valve. The visceral disk region of a specimen of *A.? parvispinosa* is gently but definitely swollen to form a slightly convex area. The spines of the Texas species are fine and numerous but indications from the few spine bases seen on *A.? occidentalis* suggest much stronger spines. This would be in agreement with the larger size of the Oregon species.

Shells similar to the Permian *Alexenia?* are common in the Pennsylvanian and occur fairly frequently in the Wolfcamp and Leonard formations of the Glass Mountains. None of these, except Stehli's species, appears to have been named.

ALEXENIA? SUBQUADRATA Cooper, new species

Plate 2A, figures 1-4

Shell small, slightly wider than long; lateral margins gently rounded; anterior margin gently rounded; anterolateral extremities moderately rounded; posterior half fairly strongly reticulated; anterior half costellate; costellae subequal, separated by spaces narrower than the costellae, numbering about 6 in 5 mm. at the front margin.

Pedicle valve with lateral profile moderately convex and with the geniculation at about the middle and forming an angle of 90°. Posterior half somewhat less convex than the anterior half or trail. Beak narrow, incurved, scarcely protruding beyond the hinge line. Umbo narrowly and strongly swollen and with precipitous slopes to the ears. Sulcus originating about 12 mm. anterior to the beak, narrow and shallow but extending to the anterior margin and forming a broad V in profile. Flanks bordering sulcus moderately broad and moderately swollen and with steep slopes to the margins. Ears small. Spines concentrated on lateral slopes, scattered on trail.

Measurements in mm.—Holotype, length 22.1, width at middle 26.1, width at ears 26.0, surface length 40.0, height 13.8.

Type.—Holotype, U.S.N.M. 125328.

Localities.—L8; S106.

Discussion.—This species is characterized by its subquadrate form, deep sulcus, and strong convexity. It differs from *A.? occidentalis*,

new species, in its narrower outline, shorter trail, deeper sulcus, and more strongly convex lateral profile. The species is represented by a single specimen only, but it is fairly well preserved.

Family ECHINOCONCHIDAE Stehli, 1954

KOCHIPRODUCTUS TRANSVERSUS Cooper, new species

Plate 4A, figures 1-6

Shells moderately large, wider than long and with moderate depth. Sides rounded, anterior margin broadly rounded; anterolateral extremities narrowly rounded. Surface marked by discontinuous costellae swollen anteriorly to form spine bases.

Pedicle valve with moderately convex lateral profile; anterior profile moderately convex but with steep lateral slopes and sulcate median region. Umbo greatly swollen, beak strongly incurved. Sulcus originating on the umbo near the beak, extending to the anterior margin, becoming broader and deeper to the valve middle but becoming still broader but shallower anterior to the middle. Flanks bounding sulcus narrowly rounded. Cardinal extremities not alate. Anterior margin with short, ventrally deflected frill.

Brachial valve gently concave in lateral view but nearly flat when seen from the posterior. Umbo marked by a shallow pit anterior to which a low, broad fold rises and extends to the anterior margin. Fold steepest and somewhat carinate near the valve middle, flattening and broadening anterior to the middle but remaining prominent. Shell bounding fold gently concave; posterolateral extremities nearly flat. Cardinal process long and slender, curved.

Measurements in mm.

	Length	Middle width	Surface length	Thickness
Holotype	36.6	44.5	56.0	16.1
Paratype (125331)	42.7?	55.4	62.0?	?

Types.—Holotype, U.S.N.M. 125332; figured paratype, U.S.N.M. 125331.

Localities.—P10, P11; S12, S41, S50, S103; U.O. 2201-1, 2216-1.

Discussion.—This species is characterized by its medium size for the genus, transverse form and broad sulcus becoming obsolete anteriorly. The specimens assigned to this new species appear to be adults and not the young of *K. porrectus* which is more strongly ornamented. The adult character appears in the short ventrally deflected rim along the margin of the pedicle valve (pl. 4A, fig. 4).

The development of a rim seldom takes place in productoids except in the adult.

This species differs from *K. porrectus* in other features beside the ornamentation as mentioned above. The sulcus originates near the beak and is broader than that of the Russian species. *Kochiproductus transversus* is a smaller and wider species than the two known American species, *K. peruviana* (d'Orbigny) and *K. victorioensis* (R. E. King).

KOCHIPRODUCTUS cf. K. PORRECTUS (Kutorga)

Plate 4B, figure 7

Productus porrectus KUTORGA, Verhandl. Russ.-Kais. Min. Ges., St. Petersburg, 1844, p. 96, pl. 10, fig. 3; TSCHERNYSCHEW, Mém. Com. Géol., St. Petersburg, vol. 16, No. 2, pp. 301, 634, pl. 55, fig. 1, pl. 56, fig. 4, pl. 62, fig. 2; p. 637, fig. 7, 1902.

The specimen placed under this heading is a large productoid, the largest occurring in the fauna under consideration and one of the largest known in this country. Only part of both valves are preserved and these have become somewhat displaced so that the beak is shoved some distance over the hinge line. The beak is narrow and the umbo strongly swollen. A shallow sulcus originates on the umbo but its anterior extent and depth cannot be ascertained. The brachial valve is gently concave but shows evidence of the origin of a low fold about 18 mm. anterior to the beak. The surface is costellate and reticulate. The costellae are narrowly rounded and separated by spaces wider than the costellae. The reticulation is produced by narrow, concentric rugae. Where an undulation and costella meet, a node is produced which probably was the seat of origin of a short spine.

Detailed measurements are not possible because the specimen is so incomplete but its length and width were in excess of 70 mm. The size and ornamentation of the Oregon specimen are similar to those of a specimen figured by Tschernyschew (1902, pl. 55, figs. 1a, 1b.)

Type.—Figured specimen, U.S.N.M. 125333.

Localities.—614; S87, S106; U.O. 2202-2.

WAAGENONCONCHA PARVISPINOSA Cooper, new species

Plate 4C, figures 8-12

Shell small for the genus, wider than long, but somewhat rectangular in outline; sides rounded; front margin subtruncated. Surface covered by a mat of fine spines arranged quincuncially, about 9 to 16 in 4 square mm. near the front.

Pedicle valve moderately convex in lateral profile and with the greatest convexity located in the umbonal region; beak strongly incurved; umbonal region narrowly swollen and marked off from main body of valve by steep slopes; sulcus shallow, equal in width to about one-quarter the valve width or less, originating about 4 mm. anterior to the curved umbo; areas bounding sulcus moderately swollen; slopes to margins steepening posteriorly and steepest along the umbo; cardinal extremities flattened.

Brachial valve nearly flat in profile, but strongly geniculated around the margin; point of geniculation 15 mm. anterior to beak; umbonal region concave; fold low, widening anteriorly and originating about 5 mm. anterior to the beak. Grooves bounding sulcus shallow, deepest near the middle; flanks slightly swollen.

Measurements in mm.—Holotype (pedicle valve), length 17.6, width (based on half measure) 24, height 6.5; paratype, U.S.N.M. 125462a (brachial valve), length 16.1, hinge width 17.1; midwidth 23.6.

Types.—Holotype, U.S.N.M. 125353; figured paratypes, U.S.N.M. 125352a, 125354; unfigured paratypes, U.S.N.M. 125352b, 125462a,b.

Localities.—636; F; P12; S46, S103; U.O. 2205-1.

Discussion.—This species is characterized by its small size, the geniculated anterior margin of the brachial valve and the very fine spines. The largest specimen from Oregon is about the same size as the type specimen of *W. montpelierensis* figured by Girty (1910), but the Oregon species is more deeply sulcate on the pedicle valve and has a somewhat more prominently folded brachial valve and finer spines. Girty's illustrations do not indicate the strong geniculation of the anterior margin of *W. montpelierensis* that is such a prominent character of the Oregon species. If this were present in the Idaho form, a fairly deep trough would appear parallel to the margin.

ECHINOCONCHUS INEXPECTATUS Cooper, new species

Plate 8C, figures 13-26

Shell small to medium size for the genus, somewhat trapezoidal to pentagonal in outline; sides broadly rounded; greatest width located at about two-thirds the length from the umbo. Hinge narrower than the shell at its widest part, equal to about two-thirds the width. Anterolateral extremities narrowly rounded; front margin gently rounded. Surface of both valves marked by conspicuous concentric growth lamellae bearing rows of spines of more than one size.

Pedicle valve strongly convex in lateral profile with the beak and umbo curved over the hinge line; beak curved over and pointing at

the dorsal umbo. Umbonal region narrowly convex and with steep, almost vertical slopes to the cardinal extremities. Median region somewhat inflated; lateral slopes and anterior slope very steep to the margins. Cardinal extremities auriculate, ears small, forming an obtuse angle (118°). Median portion of valve slightly depressed by an almost imperceptible sulcus which may or may not reach the anterior margin.

Brachial valve trapezoidal in outline, moderately concave with the deepest part located just anterior to the umbo. In front of this deep part a barely perceptible fold extends anteriorly to the front margin. Areas extending obliquely to anterolateral extremities and bounding the fold moderately deep. Cardinal extremities deflected in a dorsal direction, flattened; marginal parts of valve forming a well bounding the concave portion.

Measurements in mm.—Holotype, length 27.8, width 30.4, thickness at middle 12.2, height 15.7, length of brachial valve 21.8, surface measure 50; paratype, U.S.N.M. 125357, length 25, width 25.5, thickness at middle 9, height 12.8, length of brachial valve 20.9; paratype, U.S.N.M. 125358, length 22.5, width 23.9, thickness at middle 8.8, height 11.3, surface length 36, length of brachial valve 18.7; paratype, U.S.N.M. 125454 (brachial valve), length 21.2, mid-width 32.2, hinge width 20.7, surface length 37.

Types.—Holotype, U.S.N.M. 125551; figured paratypes, U.S.N.M. 125356, 125357, 125359, 125454; unfigured paratype, U.S.N.M. 125358.

Localities.—636, 638, 639; F; P10, P11; S25, S29, S39, S40, S45, S46, S47, S50, S70, S87; U.O. 2201, 2201-1, 2202, 2204-1, 2204-3.

Discussion.—This species is most suggestive of *Echinoconchus fasciatus* (Kutorga) of described European Permian species. It differs, however, in having different dimensions, the Oregon species being shorter and wider with a broader anterior and more flaring sides.

Echinoconchus inexpectatus, new species, is a fairly common species in the Oregon Permian and is usually found in dense, hard, brownish-gray limestone having a very fine grain.

Suborder RHYNCHONELLOIDEA Moore, 1952

Superfamily RHYNCHONELLACEA Schuchert, 1896

Family CAMAROTOECIIDAE Schuchert and LeVene, 1929

WELLERELLA MULTIPLICATA Cooper, new species

Plate 10B, figures 7-11

Shell of about medium size for the genus, subtriangular in outline; wider than long and with the greatest width at about the middle; sides

rounded; front margin truncated, posterolateral margins forming an obtuse angle; paucicostate, having 5 costae on the fold of the brachial valve and 4 costae in the sulcus of the pedicle valve, and the flanks with 4 costae.

Pedicle valve gently convex in lateral profile, nearly flat in anterior profile; beak small, incurved; umbo gently swollen; sulcus originating just anterior to the middle and occupied by 4 costae; costae extending posteriorly for a short distance onto the umbo. Tongue long, geniculated at right angles, truncated anteriorly; flanks bounding sulcus not strongly elevated, flattened.

Brachial valve moderately convex in lateral profile but strongly convex in anterior profile; umbo smooth and swollen; fold originating at about the valve middle, nearly flat in anterior profile and only moderately elevated; flanks gently rounded but sloping steeply to the margins.

Measurements in mm.—Holotype, length 10.5, brachial valve length 9.5, maximum width 12.0, thickness 7.8; paratype, U.S.N.M. 125467b, length 9.8, brachial valve length 8.9, maximum width 10.7, thickness 9.1.

Types.—Holotype, U.S.N.M. 125467a; unfigured but measured paratype, U.S.N.M. 125467b.

Locality.—S87.

Discussion.—This species is characterized by its globular form, its low fold, and the presence of 4 costae in the sulcus and 5 on the fold. This species has an exterior resemblance to *W. pinguis* (Girty) and *W. shumardiana* (Girty) but it differs from both of them in being much smaller and in having more costae in the sulcus and on the fold. *Allorhynchus? permianus* Stehli has a fold and sulcus with a similar number of costae but this species is costate over the umbones as well as on the anterior half. Furthermore, Stehli's species has more costae on the flanks than the Oregon species. No other described *Wellerella* is close to this one.

Superfamily STENOSCISMATACEA Shrock and Twenhofel, 1953

Family STENOSCISMATIDAE Muir Wood, 1955

STENOSCISMA MUTABILE OREGONENSE Cooper, new subspecies

Plate 9C, figures 15-28

Shell of about medium size for the genus, body slightly wider than long, somewhat triangular in outline with beak and sides forming an angle of about 90°; greatest width anterior to the middle; posterolateral margins narrowly rounded; front margin nearly straight.

Surface marked by 10 to 11 rounded costae separated by spaces narrower than the costae; sulcus marked by 4 costae, the median 2 of which extend to the umbo and the other 2 intercalated outside the median costae and appearing at about the middle or slightly posterior to the middle; fold marked by 5 costae, the 3 median ones strong and extending to the umbo, the 2 outside ones appearing on the sides of the outer 2 strong median costae but not extending posterior to the middle. Flanks marked by 2 or 3 costae.

Ornamentation in addition to costae consisting of wide and wrinkled frills extending laterally for fully 7 mm. on each side of the valve and for an undetermined distance anteriorly.

Pedicle valve gently convex with the greatest convexity located in the umbonal region. Beak strongly incurved; sulcus originating about one-third the length from the umbo, shallow throughout but becoming very wide anteriorly and occupying slightly less than two-thirds the valve width at the front. Tongue moderately long, truncated anteriorly. Flanks narrow, flattened anteriorly but with steep slopes and rounded sides posteriorly.

Brachial valve moderately convex in lateral profile and more strongly convex in anterior profile; maximum convexity slightly posterior to the middle. Umbonal region gently convex; fold originating about one-third the length anterior to the umbo, low, gradually widening but occupying only half the width at the front margin. Flanks narrowly rounded and with steep slopes to the margins.

Measurements in mm.

	Length	Brachial length	Width	Width with frill	Thickness
Holotype	11.8	10.6	14.5	?	8.0
Paratype (125379)	12.2	11.0	15.0	29.6	?
Paratype (125377)	12.5	11.1	16.4	?	8.0

Types.—Holotype, U.S.N.M. 125378; figured paratypes, U.S.N.M. 125377, 125379, 125380.

Localities.—638; L8; P10; S14, S20, S40, S41, S46, S50; U.O. 2201-4, 2204-1, 2204-3.

Discussion.—This subspecies is represented by 4 specimens, all of them approximately of the same size, about one-half inch in width. Small size is the chief distinction between the Russian species *S. mutabile* and its American subspecies. A comparison of Tschernyschew's figures of *S. mutabile* of comparable size (Tschernyschew, 1902, pl. 45, figs. 2 and 4) shows the development of the costae in

the fold and sulcus to be essentially the same as that of the American specimens, with the exception that the intercalated costae on each side of the median 2 in the sulcus are longer than in the Russian specimen of comparable size. Furthermore, the costae of the Oregon specimens are somewhat more slender than those of the Russian specimens. In Russia the species attains a width of about 1 inch or about twice the size of the Oregon specimens.

STENOSCISMA AMERICANUM Cooper, new species

Plate 9D, figures 29-33

Shell small, valves of subequal depth, subtriangular in outline, incomplete (lacking the frills), slightly wider than long. Posterolateral margins straight, lateral margins narrowly rounded, anterior margin truncated; valves paucicostate, the umbo of both valves smooth but the remainder costate. Costae numbering about 15 or 16, 4 on the fold, 1 on each side of the fold, and 4 or 5 on the flanks.

Pedicle valve slightly less deep than the brachial valve, gently convex in lateral profile, flattened in anterior profile; sulcus originating just anterior to the umbo, shallow but wide, occupying more than half the width at the front; sulcus occupied by 3 primary costae, but 1 or 2 costae are intercalated on the slope on each side of the primary 3; tongue bent nearly at a right angle, long, and broadly rounded; flanks bounding sulcus narrowly rounded.

Brachial valve gently convex in lateral profile, strongly rounded in anterior profile; fold originating just anterior to the smooth umbo, low but wide, and occupied by 4 primary costae. Secondary costae intercalated on sloping sides of fold; flanks bounding fold convex but depressed below the fold; umbo swollen.

Measurements in mm.—Holotype, length 11.2, brachial length 9.7, width 12.0, thickness 9.0.

Type.—Holotype, U.S.N.M. 125381.

Locality.—S20.

Discussion.—This species is similar to *S. mutabile oregonense* but differs in its ornamentation and the smooth umbones of both valves. It is similar to *S. karpinskyi* (Tschernyschew) but differs in having smooth umbones rather than plicated ones and the details of the ornamentation are somewhat different. On the pedicle valve of *S. americanum*, new species, the fold has only 4 costae but 2 additional ones are intercalated on the sloping side of the fold, unlike *S. karpinskyi* as illustrated by Tschernyschew (1902, pl. 60, figs. 2, 3), in

which the adult has 6 costae on the fold. In the brachial valve the lateral intercalations in the sulcus are shorter than those in the Russian species which extend up to the umbo.

STENOSCISMA BIPLICATOIDEUM Cooper, new species

Plate 9E, figures 34-54

Shell of about medium size for the genus, transversely pentagonal in outline, beak obtuse; sides narrowly rounded. Surface sparsely costate, the fold provided with 3 costae, the sulcus with 2, and the flanks with 2 distinct but short costae and a third obscure one.

Pedicle valve moderately convex in lateral profile; umbonal region gently convex; sulcus originating at about the middle, shallow and occupying slightly less than half the width at the front. Tongue moderately long, narrowly rounded; costae in sulcus strongest near anterior margin. Flanks gently convex with gentle slopes to the margin.

Brachial valve slightly deeper and more convex than the pedicle valve; moderately convex and with the greatest convexity at the middle in lateral profile; fold originating about one-third the length from the dorsal beak, not strongly elevated, with costae fairly broad and separated by spaces narrower than the costae. Slopes of fold steep; flanks somewhat narrowly rounded and with steep slopes to the margins.

Measurements in mm.—Holotype, length 17.0, brachial length 14.8, width 16.9, thickness 11.3.

Types.—Holotype, U.S.N.M. 125382; figured paratypes, U.S.N.M. 125383, 125384a-d; unfigured paratype, U.S.N.M. 125461.

Localities.—L8; P10; S47; U.O. 2205-5.

Discussion.—This species differs from *S. biplicata* (Stuckenberg) as figured by Tschernyschew in its more transverse outline and the lesser development of the costae which in the American species are distinct only to about the middle of the valves. Furthermore, the sulcus is shallower and the fold somewhat narrower and lower than that of the Russian species. The most significant difference appears in the anterolateral angles which are narrower in the American form than in the Russian one and the tongue of the pedicle valve of the American species is more extended to give the valve a somewhat nasute appearance.

STENOSCISMA cf. S. PLICATUM (Kutorga)

Plate 10E, figures 32-35

Pentamerus plicatus KUTORGA, Verhandl. Russ-Kais. Min. Ges., St. Petersburg, p. 89, pl. 9, fig. 3, 1844.

Camarophoria plicata (Kutorga) TSCHERNYSCHEW, Mém. Com. Géol., St. Petersburg, vol. 16, No. 2, pp. 92, 502, pl. 21, fig. 1, pl. 50, figs. 17, 18, 1902.

Several specimens of a large but poorly preserved *Stenosisma* are compared to Kutorga's species. An uncrushed pedicle valve is 27 mm. long by 30 mm. wide at the widest part which is anterior to the middle. The sulcus originates near the middle and is occupied by 5 costae and the flanks by 6 costae.

A crushed complete specimen shows a long tongue on the pedicle valve and a low fold occupied by 6 costae. Although the two specimens do not attain the full size of Kutorga's species, the characters indicated are in accord with the Russian species.

Types.—Figured specimens, U.S.N.M. 125385a,b.

Localities.—S87, S103, S106; U.O. 2201-4, 2202-1, 2202-2, 2202-6.

Superfamily RHYNCHOPORACEA Moore, 1952

Family RHYNCHOPORIDAE Muir-Wood, 1955

RHYNCHOPORA MAGNA Cooper, new species

Plate 9A, figures 1-10; plate 10D, figures 18-31

Shell large for the genus, pentagonal in outline, triangular in lateral profile. Beak obtuse, greatest width slightly anterior to the middle. Greatest thickness at the anterior. Anterior margin slightly convex. Shell provided with 24 to 26 costae, with 8 on the fold, 7 in the sulcus, and 9 on the flanks.

Pedicle valve gently convex in lateral profile, with the anterolateral flanks reflected. Maximum convexity slightly posterior to the middle. Umbo and median region slightly inflated; sulcus originating at the middle, shallow and broad, slightly swollen in the middle and occupying slightly more than half the width. Flanks bounding sulcus slightly concave posteriorly but anterolaterally folded into a low plica. Tongue long and truncated in front. Interior with long, stout dental plates.

Brachial valve gently convex in lateral view, narrowly convex in anterior profile; umbonal and median regions slightly swollen. Fold low and broad, originating at about the middle, protruding slightly anteriorly; flanks rounded and extended, with steep slopes and with sharp geniculation to unite with the reflected anterolateral extremities of the pedicle valve.

Measurements in mm.

	Length	Width	Thickness
Holotype	18.6	20.9	17.8
Paratype (125389)	19.1	22.8	19.0
“ (125393)	16.5	19.2	14.5
“ (125391a)	11.8	13.8	9.4
“ (125390)	10.6+	12.4	9.6

Types.—Holotype, U.S.N.M. 125392; figured paratypes, U.S.N.M. 125388, 125389, 125390, 125391a, 125393, 125552; unfigured paratype, U.S.N.M. 125391b.

Localities.—613, 636, 637, 638, 639; F; L8; P10; S20, S39, S40, S45, S46, S49, S56, S87, S103; U.O. 2201-1, 2202-2, 2204-1.

Discussion.—This is the largest species of *Rhynchopora* yet found in the United States. It is coarser ribbed than large specimens of either *R. illinoisensis* (Worthen) or *R. carbonaria* (McChesney). *Rhynchopora taylori*, best-known species from the Permian, is a smaller shell with a narrower fold and sulcus. In the Oregon species the fold and sulcus occupy most of the anterior part, the flanks being small and restricted. None of the numerous specimens of *Rhynchopora* from the Leonard and Word formations of the Glass Mountains approaches *R. magna* in size or in the strength of the costation.

RHYNCHOPORA sp.

Plate 9B, figures 11-14

The specimen illustrated is probably an aberrant specimen of *Rhynchopora magna* Cooper, new species, which may have, because of unfavorable or unusual conditions, attained adulthood without ever growing to normal size. Adult characters in this specimen appear in the long tongue of the pedicle valve and the great depth of the brachial valve.

Type.—Figured specimen, U.S.N.M. 125387.

Localities.—S49, S103; U.O. 2201-4.

Suborder SPIRIFEROIDEA Allen, 1940

Superfamily SPIRIFERACEA Waagen, 1883

Family SPIRIFERIDAE King, 1846

Subfamily AMBOCOELIINAE George, 1931

CRURITHYRIS sp. 1

Plate 1G, figures 13-18

Longer than wide, maximum width at about the middle, lateral margins narrowly rounded; anterior margin truncate. Anterior commissure faintly sulcate. Surface smooth.

Pedicle valve having the greater depth; strongly convex in lateral profile especially just anterior to the umbo. Beak long and strongly incurved. Umbo narrow, elongate. Median region swollen.

Brachial valve convex in about the posterior third but flattened anteriorly. Anterior profile nearly flat. Posterolateral extremities deflected toward the pedicle valve, rounded.

Measurements in mm.—Figured specimen, U.S.N.M. 125463, length 6.6., brachial length 5.2, maximum width 5.6, hinge width 3.4, thickness 4.0.

Type.—Figured specimen, U.S.N.M. 125463.

Locality.—S46.

Discussion.—The small size of this *Ambocoelia* makes it unusual in the American Permian. It is longer than wide whereas most other species are wider than long. *Ambocoelia arcuata* Girty from the Phosphoria formation is a larger species and has a different outline. It is also not flattened anteriorly as is the Oregon species. Schellwien's *A. telleri* and Netschajew's *A. nucella* are small species but they are strongly biconvex, quite unlike typical *Ambocoelia* or *Crurithyris*. The specimen figured herein is the only one in the Oregon collection; consequently, it is impossible to tell whether it is a young form or an adult.

Subfamily TRIGONOTRETINAE Schuchert, 1893

SPIRIFERELLA DRASCHEI (Toula)

Plate 11C, figures 7-20

Spirifera draschei TOULA, Neues Jahrb. Mineral., Geol., Palaeont., p. 239, pl. 7, fig. 4, 1875.

Spiriferella draschei (Toula) BRANSON, Geol. Soc. Amer. Mem. 26, p. 506, 1948.

Spiriferina (*Spiriferella*) *salteri* TSCHERNYSCHEW, Mém. Com. Géol., St. Petersburg, vol. 16, No. 2, pp. 128, 528, pl. 6, fig. 5, pl. 12, figs. 5, 6, 1902.

Smaller than the type, moderately thin-shelled; longer than wide, with a pentagonal outline. Sides slightly convex, anterior margin subtruncate. Surface fascicostellate and pustulose; shell substance impunctate.

Pedicle valve with beak strongly curved over dorsal umbo giving the shell a top-heavy appearance. Greatest curvature umbonally, convexity moderate in the anterior half. Sulcus originating at the beak and extending to the front margin, widening gradually anteriorly to occupy about half the width at the front. Tongue long and sharply pointed. Flanks narrowly rounded and marked by about 5 fascicles of costellae; sulcus marked by a few costellae.

Brachial valve at least one-quarter the length shorter than the ventral valve, moderately convex in lateral profile but carinate in anterior profile. Fold strongly elevated, angular in section but bearing a narrow groove down the center. Flanks flattened and with long oblique slopes to the margins.

Measurements in mm.—Hypotype, U.S.N.M. 125400, length 26.9, width 22.3, thickness 17.8, length of brachial valve 20; U.S.N.M. 125406, length 34, length of brachial valve 21.9, width at middle 29+, thickness 23.5.

Types.—Figured hypotypes, U.S.N.M. 125400, 125401, 125402, 125404, 125406.

Localities.—614, 638, 639; L8, L23; P10; S4, S12, S40, S46, S47, S49, S50, S51, S56, S68, S87, S103; U.O. 2201-4, 2202-2, 2204-3, 2205-5, 2207, 2210.

Discussion.—None of the specimens of this species from Oregon is well preserved, but all appear to be typical of the Russian species.

SPIRIFERELLA PARVA Cooper, new species

Plate 11A, figures 1-5

Shell small for the genus, elongate-oval in outline; sides nearly parallel; cardinal extremities probably produced into small ears; surface fascicostellate.

Pedicle valve strongly convex in lateral profile with strongly incurved beak; umbonal and curved portion of valve approximating one-third the shell; sulcus originating at the beak, widening gradually anteriorly to occupy about half the width at the front; anterior produced into a long, sharply pointed tongue. Flanks rounded and with very steep sides. Surface marked by 5 fascicles of about 3 costellae; sulcus marked by numerous radial costellae. Deltidium prominent.

Brachial valve moderately convex with the maximum convexity located slightly posterior to the middle; carinate in anterior profile; fold originating at the beak, high and narrow, marked by slight median depression. Flanks convex and steep-sided.

Measurements in mm.—Holotype, length 22.7, width 14.9(?), thickness 17.0, length of brachial valve 16.3.

Type.—Holotype, U.S.N.M. 125405.

Locality.—U.O. 2204-3.

Discussion.—This species is characterized by its laterally compressed form and narrow fold. It is a small species, smaller than *S. draschei* (Toula). It differs from the latter by its narrower form, more incurved beak of the pedicle valve, strongly elevated and ex-

tremely narrow fold. A single specimen is all that has been taken from the Oregon Permian.

NEOSPIRIFER sp. 1

This genus is represented by fragmentary and crushed specimens, not one of them in a condition good enough for description. The shells are finely ribbed.

Types.—Mentioned specimens, U.S.N.M. 126984a,b.

Localities.—S101, S103; U.O. 2202-2.

Subfamily MARTINIINAE Waagen, 1883

PSEUDOMARTINIA BERTHIAUMEI Cooper, new species

Plate 12G, figures 50-54

Shell of about medium size for the genus, longer than wide, sides gently convex; anterior margin subtruncate. Surface mostly smooth but with obscure radial lines on the flanks.

Pedicle valve moderately convex in lateral profile with the greatest curvature in the umbonal region. Beak strongly curved over the interarea; delthyrium and interarea visible; interarea short; hinge narrow, equal to slightly less than half the shell width. Beak acute; umbo somewhat swollen; sulcus originating near the middle but well defined only in the anterior third, broad and shallow and occupying about half the width at the front. Tongue short, narrowly rounded. Flanks steep-sided and gently convex.

Brachial valve less deep than the pedicle valve, gently convex in lateral profile, subcarinate in anterior profile; fold originating at about the middle, low, clearly defined in the anterior third only, flanks steep-sided and flattened in profile. Umbonal region swollen.

Measurements in mm.—Holotype, length 22.7, length of brachial valve 18.2, width 19.7, thickness 15.8.

Type.—Holotype, U.S.N.M. 125395.

Localities.—S12, S101.

Discussion.—This species is characterized by its elongate-oval outline, the maximum width at about the middle, and the soft contours of the fold and sulcus. *Pseudomartinia berthiaumei*, new species, is unlike any described American Permian species. It is differently shaped and does not have the elongated anterior and nearly obsolete sulcus of *P. martinesi* Cooper from the Monos formation of Sonora, Mexico. It is smaller than, and with completely different outline from, Girty's two species from the Guadalupe Mountains of west

Texas, *P. shumardiana* and *rhomboidalis*. Both of these species are more nasute than the Oregon species.

Of species described outside North America, *P. berthiaumei*, new species, is very close to *P. semiglobosa* (Tschernyschew) from the "Schwagerina" limestone of the Urals but differs in having a more convex brachial valve and less strongly rounded sides. Another Russian species having some similarity is *P. uralica* (Tschernyschew), but that one is more elongated and has a very modest development of the fold and sulcus, even less than in the Oregon species.

Although the holotype specimen is somewhat crushed, the growth lines are clear in places and show the lateral margin to have been only gently convex.

PSEUDOMARTINIA aff. **P. SEMIGLOBOSA** (Tschernyschew)

Martinia semiglobosa TSCHERNYSCHEW, Mém. Com. Géol., St. Petersburg, vol. 16, No. 2, p. 564, pl. 17, figs. 6-10, 12, 13, 1902.

A fragmentary specimen is referred to Tschernyschew's species but it is impossible to make a more satisfactory identification. The profile and size of the valves agree as far as they are preserved. The fold and sulcus are indicated as low and of gentle contours and the tongue of the pedicle valve is short and rounded. These are features shared by Tschernyschew's type specimens. The umbo of the brachial valve of the Oregon specimen is narrower and the beak smaller than that of the Russian specimens. This is, however, the only important difference between the two.

Measurements in mm.—Described specimen, U.S.N.M. 125456, brachial valve length 21.2, width 23.2 (based on half measure), height about 6.

Type.—Described specimen, U.S.N.M. 125456.

Localities.—S12; U.O. 2201-1, 2202-2, 2219-1, 2225.

Subfamily PHRICODOTHYRINAE Caster, 1939

SQUAMULARIA ROSTRATA (Kutorga)

Plate 10F, figures 36-42

Spirifer rostratus KUTORGA, Verhandl. Russ.-Kais. Min. Ges., St. Petersburg, 1842, p. 25, pl. 5, fig. 10.

Reticularia rostrata TSCHERNYSCHEW, Mém. Com. Géol., St. Petersburg, vol. 16, No. 2, p. 575, pl. 20, figs. 17 and 18, 1902.

Squamularia rostrata (Kutorga) BRANSON, Geol. Soc. Amer. Mem. 26, p. 521, 1948.

A single specimen is referred to this species, although differences are apparent between it and Tschernyschew's figure of Kutorga's

specimen *S. rostrata*. The latter has a considerably narrower and more elevated beak than the one from Oregon. Nevertheless, the specimen figured by Tschernyschew (1902, pl. 20, fig. 17), which comes from the "*Schwagerina*" zone, is very close to the Oregon species. This Russian specimen has not the strongly elevated beak of Kutorga's type and may ultimately prove to be distinct. The matter, however, cannot be settled on the single Oregon specimen, which is slightly crushed.

Type.—Hypotype, U.S.N.M. 125396.

Localities.—633?, 638; L8; P10, P11, P12; S41, S43, S46, S56, S103, S106; U.O. 2201-1, 2202-4, 2204-1, 2204-3.

Superfamily ROSTROSPIRACEA Schuchert and LeVene, 1929

Family ATHYRIDAE Davidson, 1884

CLEIOTHYRIDINA ATTENUATA Cooper, new species

Plate 11D, figures 21-27

Small, suboval in outline, length and width nearly equal; maximum width at middle; posterolateral margins nearly straight and forming an angle of 90° at the beak; sides strongly rounded; anterior margin strongly rounded; anterior commissure rectimarginate. Surface details indistinct but marked by closely spaced concentric lamellae bearing spines.

Pedicle valve gently convex in lateral profile, strongly convex in anterior profile; beak and umbo narrow; umbo narrowly swollen; median region swollen; flanks flattened but steep. Beak incurved and extending posterior to the margin of the brachial valve.

Brachial valve shallower than the pedicle valve, gently convex in lateral profile but strongly convex in anterior profile; umbonal region somewhat narrowed; median region strongly swollen and forming the most convex part. All slopes to the margins steep.

Measurements in mm.—Holotype, length 12.3, brachial length 11.2, maximum width 11.9, thickness 7.2.

Types.—Holotype, U.S.N.M. 125394a; unfigured paratype, U.S.N.M. 125394b.

Localities.—S45, S87; U.O. 2205-5.

Discussion.—This species is characterized by small size and small attenuate beak. This genus is at present not described from the American Permian, although it occurs in the Wolfcamp of west and north-central Texas. The Wolfcamp species is a small one but does

not have the narrowed beak of the Oregon species. The same difference separates the Oregon species from *C. pectinifera* (Sowerby) as figured by Tschernyschew (1902, pl. 43, fig. 4). The species of *Cleiothyridina* from Pakistan and Timor are all large forms.

Netschajew (1911, pl. 13) figures a variety of small to medium-sized *Cleiothyridina* under the name of *C. pectinifera* (Sowerby), some of which are somewhat attenuated but none of which are like the Oregon species.

CLEIOTHYRIDINA GERARDI (Diener)

Plate 11E, figures 28-31

Athyris gerardi DIENER, Palaeont. Indica, Geol. Surv. India, ser. 15, vol. 1, pt. 2, p. 56, pl. 6, figs. 12-14, 1899.

Cleiothyridina gerardi (Diener) BRANSON, Geol. Soc. Amer. Mem. 26, p. 317, 1948.

Two specimens of a large and transverse *Cleiothyridina* have features of this species. The figured specimen preserves both valves but the beak of the pedicle valve is missing. The pedicle valve is gently convex in profile and is devoid of a sulcus, although the anterior is considerably flattened. The brachial valve is slightly deeper than the pedicle valve and moderately convex in lateral profile. The anterior profile is strongly convex but with long and steep lateral slopes. The median region is swollen from the umbo to the anterior margin, thus forming a poorly defined fold to accommodate the anterior flattening of the opposite valve.

Only approximate measurements in millimeters are possible: Figured specimen, U.S.N.M. 125398, length 17 (probably 19 in a complete specimen), width 21, brachial length 16.7, thickness 10 or 11(?).

A second specimen of the brachial valve has spines measuring about 2.5 mm. long.

Types.—Figured specimen, U.S.N.M. 125398; mentioned specimen, U.S.N.M. 126983.

Localities.—L8; P10, P12; S103.

COMPOSITA sp. 1

A single pedicle valve of a somewhat elongate species of *Composita* is the only representation of this genus to appear in the entire collection.

Types.—Mentioned specimen, U.S.N.M. 126982.

Locality.—L8.

Superfamily PUNCTOSPIRACEA Cooper, 1944

Family SPIRIFERINIDAE Davidson, 1884

Subfamily SPIRIFERELLININAE Paeckelmann, 1931

SPIRIFERELLINA PAUCIPLICATA Cooper, new species

Plate 12F, figures 45-49

Shell of moderately large size, length and width about equal; sides gently rounded, sloping slightly toward the middle; anterior margin broadly rounded. Hinge forming the greatest width; ears acute. Surface plicate, plicae strong, direct, and angular, 2 large ones on each flank and 2 smaller ones near the ears. Surface covered by concentric plaits.

Pedicle valve unevenly subpyramidal in profile with the longer side gently convex and the shorter gently concave; sulcus deep and wide, originating at the beak and occupying about one-third the valve width at the anterior margin; tongue long and angular. Flanks bounding sulcus somewhat depressed below the strong costae bounding the sulcus; interarea long and wide, gently concave, and strongly apsacline.

Brachial valve gently convex in lateral profile with the most noticeable curvature in the umbonal region. Anterior profile broadly and gently convex; fold narrow, subangular, and strongly elevated anteriorly; flanks depressed, gently convex and marked by 2 strong and 2 weak costae.

Interior unknown.

Measurements in mm.—Holotype, length 23, brachial valve length 17.0, midwidth 24.1, hinge width (based on half measure) 25.0, thickness 15.8.

Type.—Holotype, U.S.N.M. 125464.

Locality.—S87.

Discussion.—This species is especially distinguished by its fairly large size, subangular and distant costae, and the broad, strongly apsacline interarea. No other American species of *Spiriferellina* approaches it in this combination of characters. *Spiriferellina laxa* Girty is a strongly costate species but it is much smaller than the Oregon one and has a shorter and much less inclined interarea. The species nearest like the Oregon one is a Russian shell, *Spiriferina pyramidata* Tschernyschew. The two species share a similarity of ornament, each having the same type and number of costae, but the Russian species is a larger one, is wider, and the long interarea is still more steeply inclined in the apsacline position.

PUNCTOSPIRIFER sp. 1

Plate 11B, figure 6

A single poorly preserved brachial valve and a few other fragments assignable to this genus have a broad but fairly strongly elevated and angular fold. The flanks are depressed and marked by 5 subangular costae. The best brachial valve (U.S.N.M. 125407) is 16 mm. long and 19 mm. wide. The external ornamentation is not preserved on the figured specimen but a fragment of another specimen has marked varices of growth and small papillae.

Types.—Figured specimen, U.S.N.M. 125407.

Localities.—S101; U.O. 2218-2.

Discussion.—The specimen on which the foregoing description is based is poorly preserved and the pedicle valve is missing. Nevertheless, there is a striking resemblance to a Russian specimen referred to Waagen's *S. ornata* by Tschernyschew (1902, pl. 37, fig. 9). The Oregon species also bears a resemblance to *S. holzapfeli* which is similar to Tschernyschew's specimens of *S. ornata*. The Oregon species differs from both of them in having a broader and much less elevated fold.

PUNCTOSPIRIFER sp. 2

A spiriferinoid having closely spaced concentric lamellae is assigned to this genus but the specimen is too fragmentary for description or figuring. It is mentioned only for completeness sake.

Type.—Mentioned specimen, U.S.N.M. 128253.

Locality.—U.O. 2201-1.

Family RHYNCHOSPIRINIDAE Schuchert and LeVene, 1929

Subfamily RETZIINAE Waagen, 1883

HUSTEDIA sp. 1

Plate 12E, figures 42-44

Small, longer than wide, elongate oval in outline; posterolateral margins concave; lateral margins narrowly rounded; anterior margin broadly rounded. Lateral profile gently convex, anterior profile moderately convex; umbo narrowly swollen, the swelling continued throughout the median region. Surface marked by 12 costae.

Measurements in mm.—Figured specimen, length 8.0, width 6.4.

Type.—Figured specimen, U.S.N.M. 127578.

Locality.—S25.

Discussion.—This is a poorly preserved specimen and might belong

to any of two or three species. It is similar to *H. remota* (Eichwald) as figured by Tschernyschew (1902, pl. 47, fig. 11).

Suborder TEREBRATULOIDEA Muir-Wood, 1955

Superfamily TEREBRATULACEA Waagen, 1883

Family CENTRONELLIDAE Waagen, 1882

Subfamily CENTRONELLINAE Waagen, 1882

ROSTRANTERIS MERRIAMI Cooper, new species

Plate 12B, figures 12-26

Shell small, longitudinally ovoid in outline, globular in profile. Sides and front rounded; anterior costate; 5 costae marking the brachial valve and 6 are on the pedicle valve.

Pedicle valve forming almost a semicircle in lateral profile with the maximum convexity a short distance posterior to the middle. Umbonal region narrowly swollen; beak strongly incurved over the dorsal umbo. Anterior two-thirds marked by a low fold consisting of 2 costae separating a narrow and fairly deep groove. Flanks convex and very steep to the margins, marked by 2 additional costae.

Brachial valve having about half the depth of the ventral valve, gently convex in the posterior two-thirds but strongly geniculated in a ventral direction about 5 mm. anterior to the beak. Maximum convexity at the point of geniculation. Anterior half marked by a fold, defined only at the front and consisting of 3 costae, a median one corresponding to the ventral groove and 2 lateral ones. Flanks moderately convex but with steep slopes to the margins. In anterior view this valve is provided with a long tongue that dovetails with a reentrant formed by the fold of the pedicle valve.

Measurements in mm.

	Length	Width	Thickness
Holotype	8.0	6.2	7.2
Paratype (125409b)	8.0	6.5	6.8

Interior.—Loop about 4 mm. long in a shell 6.5 mm. long and 5.4 mm. wide; median process of loop extending nearly to the front margin and slightly more than 2.3 mm. long.

Types.—Holotype, U.S.N.M. 125409a; figured paratypes, U.S.N.M. 125409b, 125560; unfigured paratypes, U.S.N.M. 125409c, 126985a,b.

Localities.—P11; S41, S50.

Discussion.—This species is unique in known American faunas. Most of the small terebratuloid species referred to *Notothyris* have no hinge plate and are referable to other genera. None of the species referred to *Notothyris* has the long median process on the loop as seen in *Rostranteris*. The Oregon species referred here to *Rostranteris* is quite clearly an adult shell and is therefore congeneric with Gemmellaro's genus. It does not, however, resemble any of the Sicilian species. The Oregon form is reminiscent of *Rhynchonella keyserlingi* Moeller, 1862, which is referred by Tschernyschew to the genus *Pugnax*. The original of this species, figured by Tschernyschew (1902, pl. 21, fig. 18), shows a small but extremely thick shell similar to *R. merriami*, new species. The Oregon species differs from the Russian one in stronger and more elevated costae, a well-defined fold on the pedicle valve made up of 2 costae with a wide sulcus between. The brachial sulcus is occupied by a single costa quite unlike the Russian species.

ROSTRANTERIS SULCATUM Cooper, new species

Plate 12A, figures 1-11

Shell small, longitudinally ovoid in outline, unequally biconvex in profile; sides convex; anterior narrowly rounded. Surface semicostate, shell substance punctate.

Pedicle valve deep, strongly and evenly convex in lateral profile, with the greatest convexity at about the middle. Beak strongly incurved; umbonal region narrowly convex. Pedicle valve marked by a broad and shallow sulcus defined by 2 prominent costae that originate near the middle of the valve and extend to the front margin, heightening and strengthening anteriorly. The sulcus is occupied by a low costa beginning anterior to the middle and strengthening in an anterior direction. Sulcus produced into a long, tapering tongue. Flanks convex, steeply sloping to the margins and provided with a single obscure costa.

Brachial valve shallower than the pedicle valve, slightly convex in lateral profile, fairly strongly convex in anterior profile. Umbo narrowly swollen; median area slightly swollen; fold originating slightly anterior to the middle short, narrow, low, and marked in the middle by a narrow sulcus corresponding to the median costa that occupies the sulcus of the ventral valve. Flanks steep-sided and convex, marked anteriorly by a single obscure costa.

Measurements in mm.

	Length	Width	Thickness
Holotype	8.6	6.3	6.0
Paratype (125408)	7.7	6.4	5.3

Types.—Holotype, U.S.N.M. 125410; figured paratype, U.S.N.M. 125408.

Localities.—S41; U.O. 2201-2, 2223-2.

Discussion.—This species has its closest affinities with *R. nucleola* (Kutorga) as redescribed by Tschernyschew. It is somewhat more elongate and slightly smaller than the Russian species and possesses a sulcate fold on the brachial valve which is not shown by Tschernyschew's specimens. It differs from *R. merriami*, new species, in its subnasute anterior, the more erect pedicle beak, and the less numerous costae on the anterior part of the valves.

Family DIELASMATIDAE Schuchert and LeVene, 1929

Subfamily DIELASMATINAE Schuchert, 1913

DIELASMA? TRUNCATUM Cooper, new species

Plate 10A, figures 1-6

Shell small for the genus, pyriform in outline, with a moderately long posterior third; rounded lateral margins but truncated front. Beak incurved, foramen labiate. Pedicle valve most convex in the posterior half and particularly in the umbonal region. Median region slightly swollen and with gentle slopes to the lateral and front margins. Brachial valve most convex in the posterior half; umbonal region swollen with moderate slopes to the posterolateral margins. Midregion gently convex.

Measurements in mm.—Holotype, length 10.6, width 8.5, thickness 6.2, length of brachial valve 8.8.

Type.—Holotype, U.S.N.M. 125411.

Locality.—S20.

Discussion.—This species is represented by two specimens only, and it is not certain that the species belongs to *Dielasma*. It is different from all the other terebratuloids seen in the Oregon Permian in its truncated front margin and rectimarginate commissure.

DIELASMA BREVICOSTATUM Cooper, new species

Plate 12D, figures 32-41

Of about medium size for the genus, longer than wide; valves unequally convex, the pedicle valve the deeper and more convex;

lateral margins gently rounded, front margin emarginated. Pedicle valve having a prominent and deep sulcus originating 15 mm. surface measure anterior to the beak; sulcus narrow and deepening anteriorly, about 21 mm. long, surface measure. Anterolateral extremities narrowly rounded. Brachial valve nearly flat, with narrow and elongate beak; anterior profile broadly convex. Anterior margin flexed dorsally to accommodate the short ventral tongue but no appreciable amount of folding takes place on the valve.

Measurements in mm.—Holotype, length 21, length of brachial valve 18.7, width 15.2, thickness 10.8; paratype, U.S.N.M. 125413b, surface length 36, length of brachial valve 20, width 15?, thickness 13.

Types.—Holotype, U.S.N.M. 125413a; figured paratypes, U.S.N.M. 125413b, 125415.

Localities.—P12; S87, S103; U.O. 2202-2, 2204-3, 2205-5, 2216-2.

Discussion.—This species is characterized by its flat brachial valve and anteriorly sulcate pedicle valve. The species most like it is *D. prolongatum* Girty but the Oregon species differs in having a much shorter sulcus in the pedicle valve and a flatter brachial valve. The sulcus in the Oregon species is deep only in the anterior third or quarter.

DIELASMA RECTIMARGINATUM Cooper, new species

Plate 12C, figures 27-31

Shell of about usual size for the genus, narrowly elliptical in all profiles; maximum width anterior to the middle; anterolateral margins broadly rounded; anterior margin truncated. Surface smooth. Anterior commissure faintly uniplicate, but no fold and sulcus defined.

Pedicle valve slightly deeper than the brachial valve, gently convex in lateral and anterior profiles; median region gently inflated.

Brachial valve gently convex in lateral profile, more strongly convex in anterior profile; beak small and acutely pointed; umbo and median region gently inflated; anterior slope long and gentle; lateral slopes steep near the margins.

Interior of pedicle valve with low median ridge extending from beak for three-fourths the length of the valve.

Measurements in mm.—Holotype, length 19.6+, brachial length 17.6, maximum width 16.3, thickness 13.0+.

Type.—Holotype, U.S.N.M. 125414.

Localities.—L23; U.O. 2201-1.

Discussion.—This species is characterized by the slender profiles,

lack of marked anterior folding, and the sharp, somewhat elongated beak of the brachial valve. It differs from all Girty's species, *D. prolongatum*, *cordatum*, *sulcatum*, and *spatulatum*, in lacking anterior folding and having only a faint trace of sulcation on the pedicle valve.

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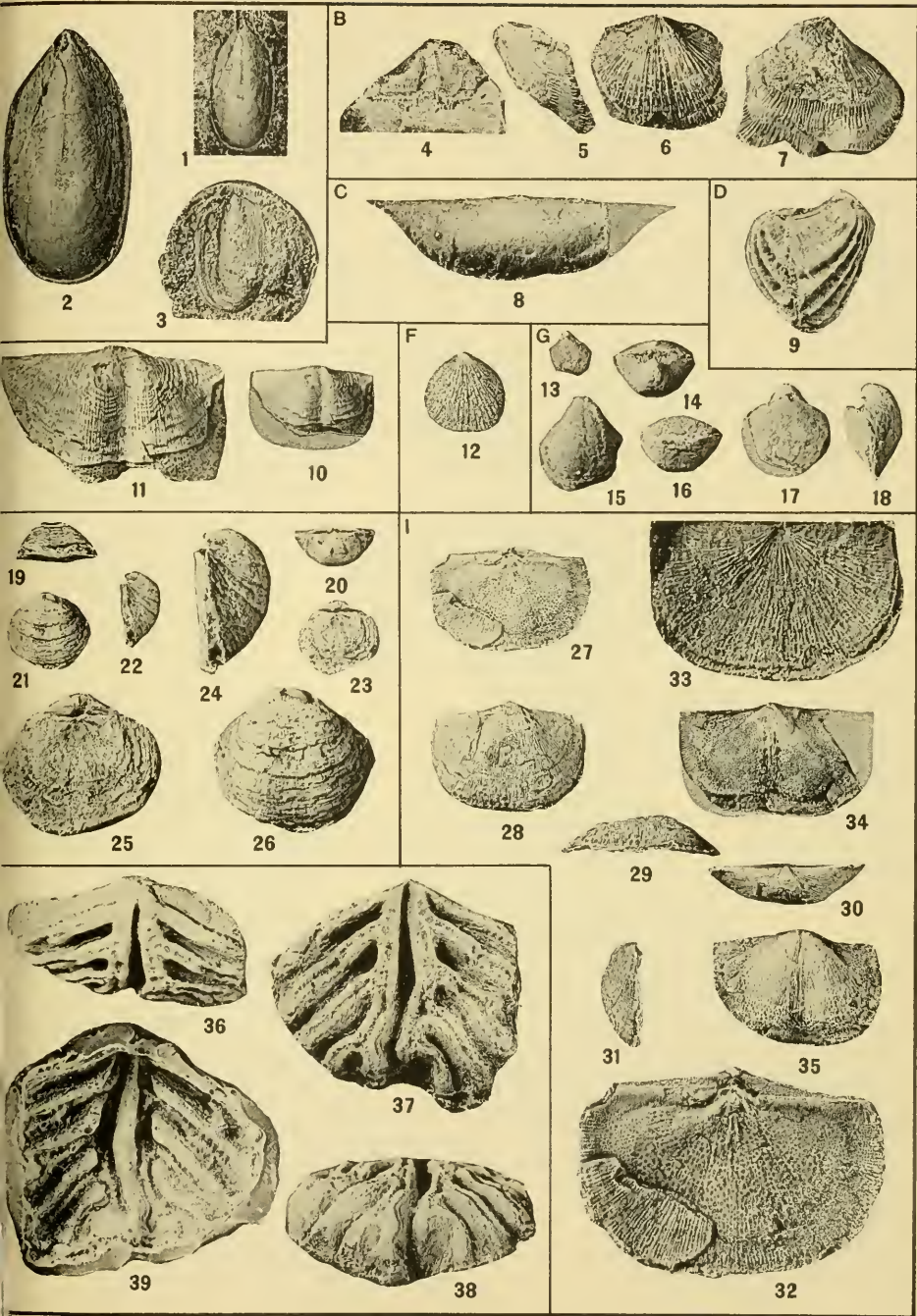
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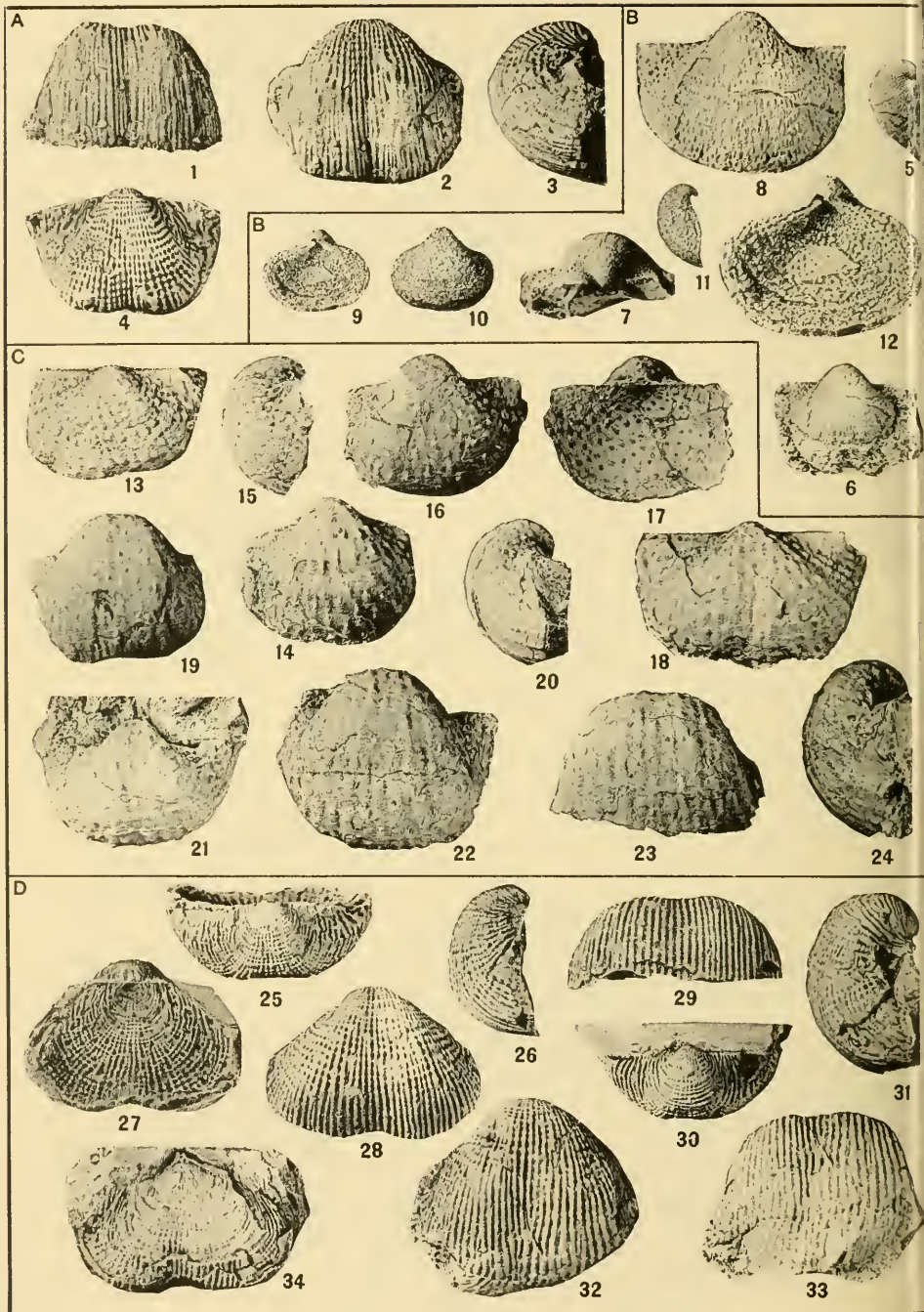
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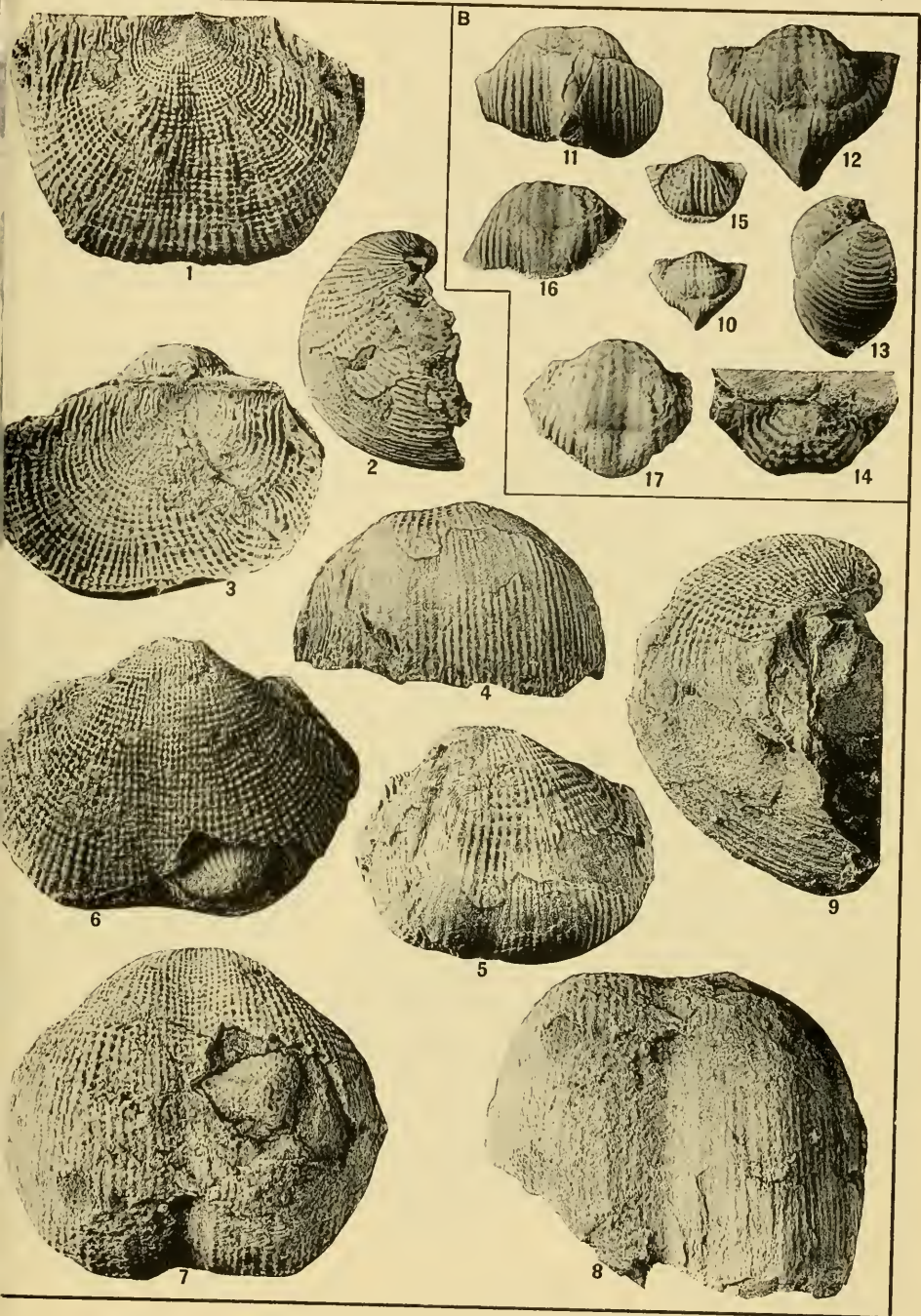
LINGULA, DERBYIA, PAECKELMANNIA, MEEKELLA, CHONETINELLA, RHIPIDOMELLA, CRURITHYRIS, CHONETES, AND LEPTODUS?

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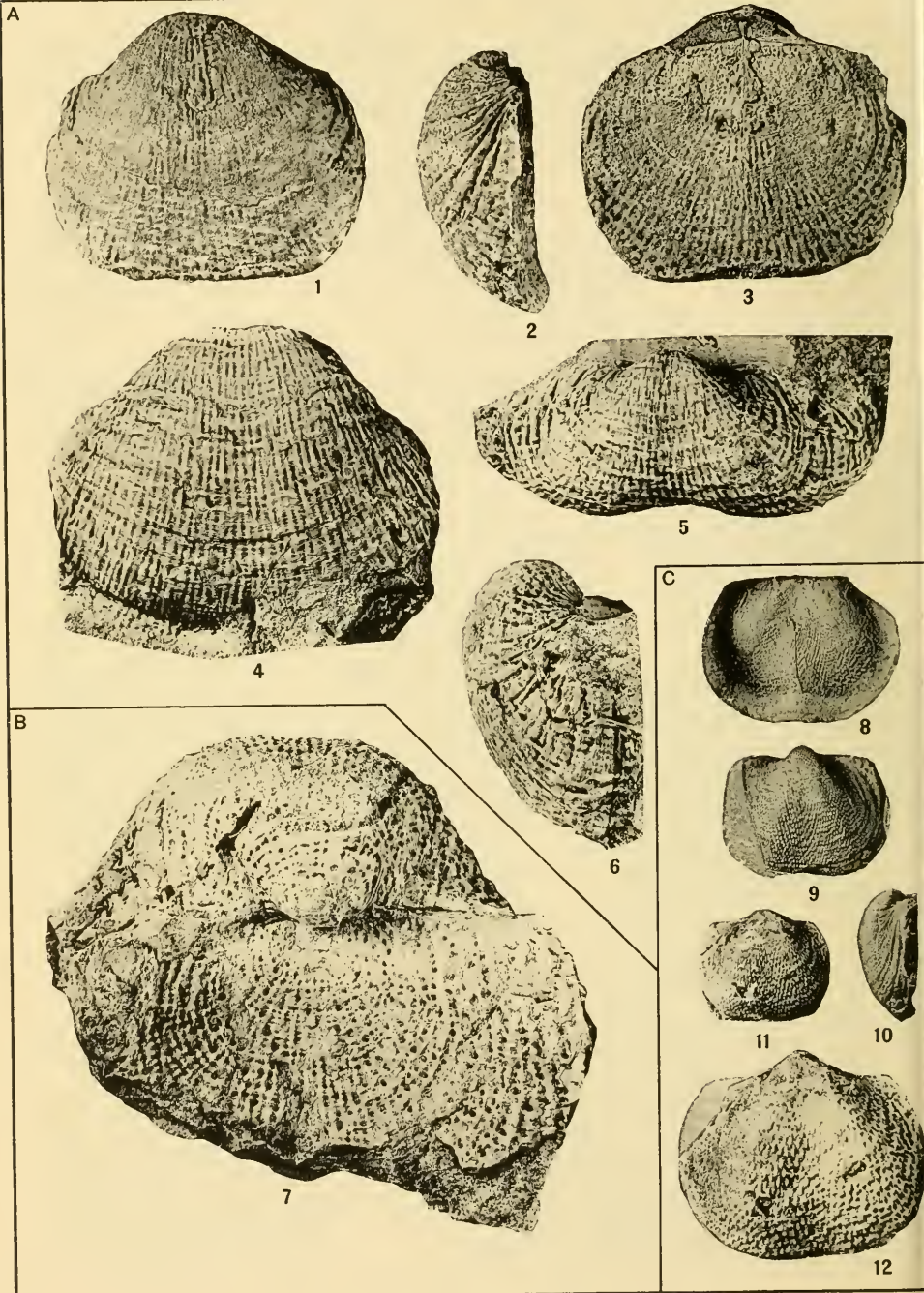


ALEXENIA?, KROTOVIA, AND AVONIA

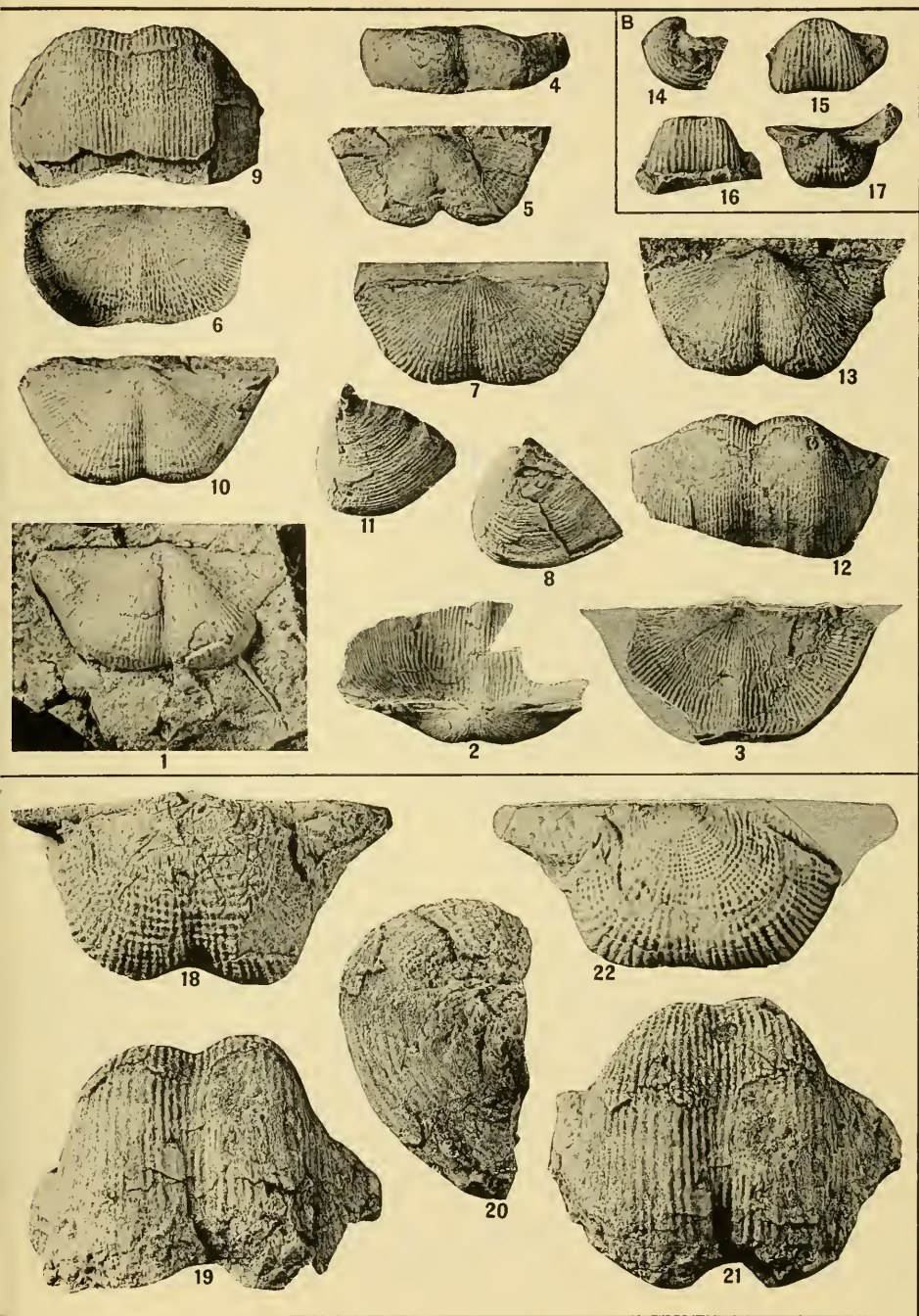
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ANTIQUATONIA AND PROBOSCIDELLA?
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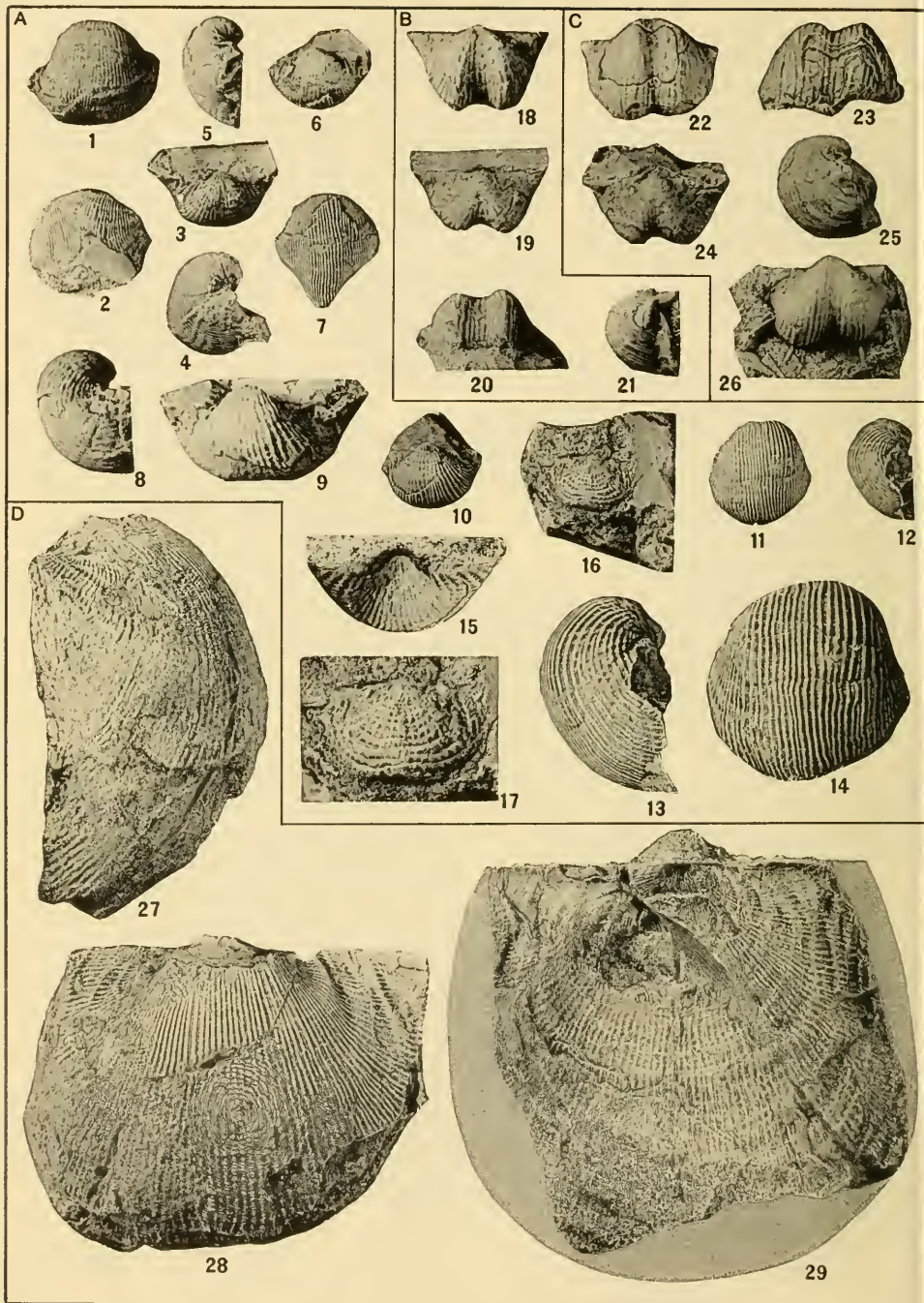


KOCHIPRODUCTUS AND WAAGENOCONCHA
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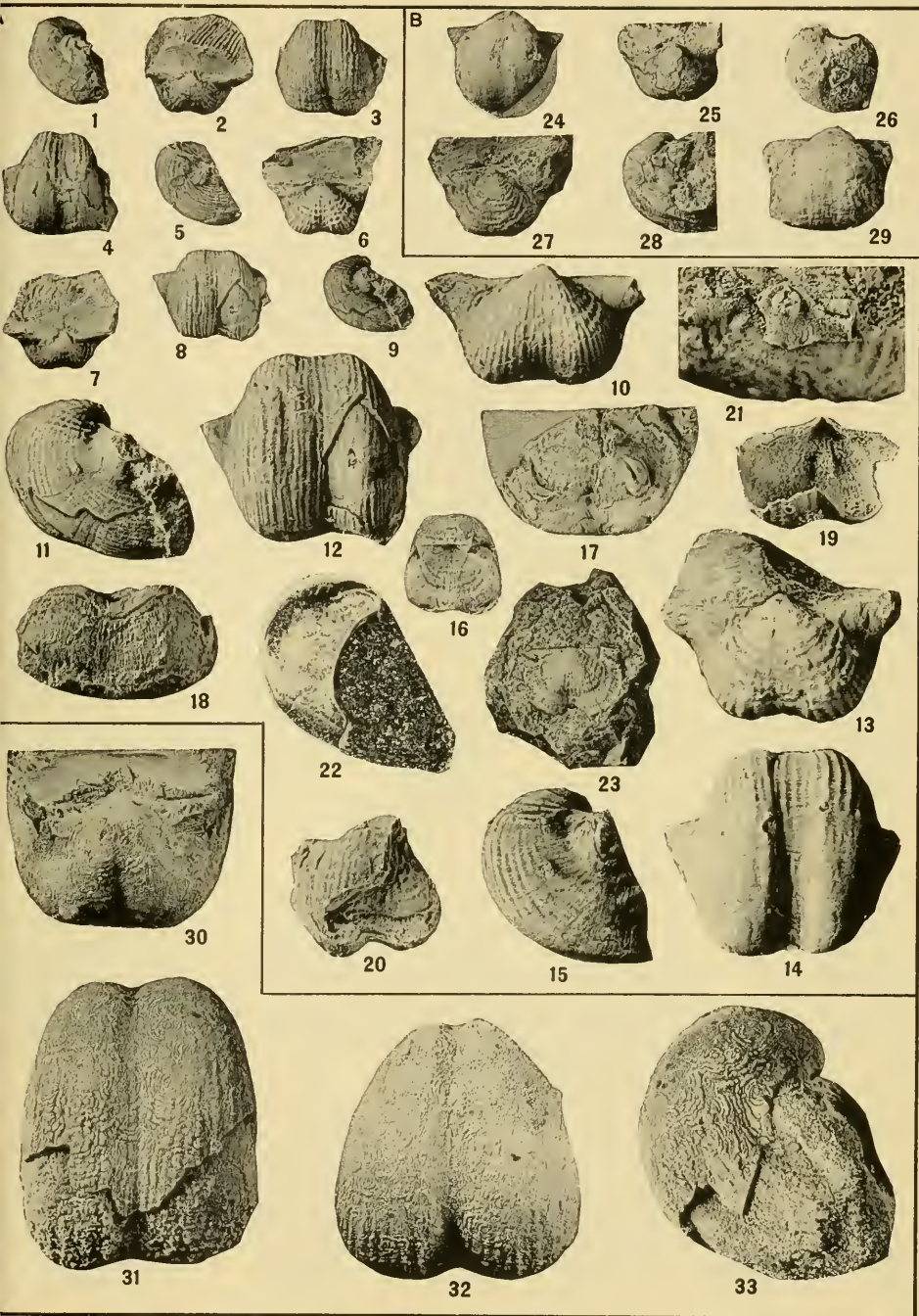
MUIRWOODIA, MARGINIFERA (?), AND ANTIQUATONIA

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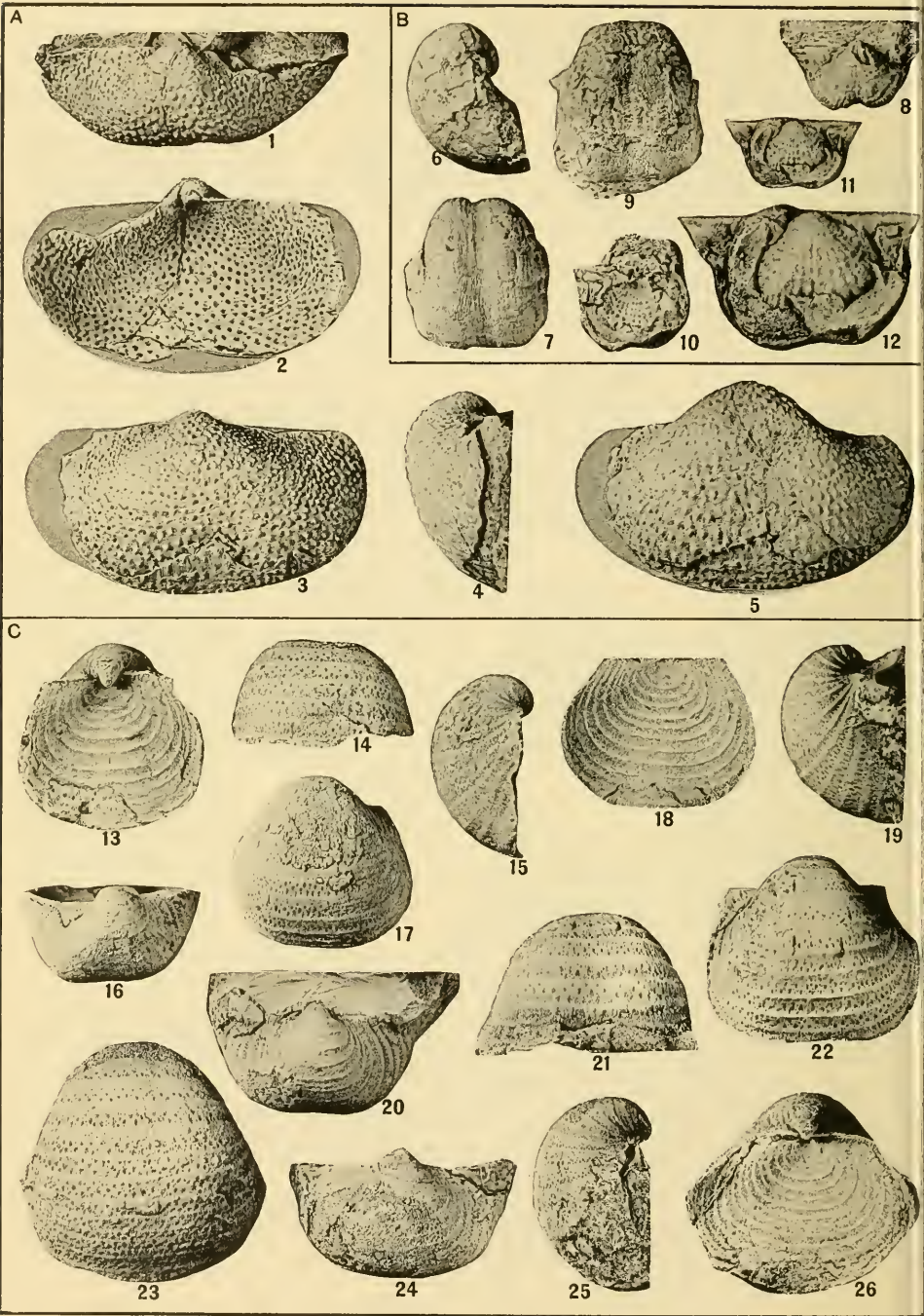
ANIDANTHUS, MARGINIFERA?, AND LINOPRODUCTUS

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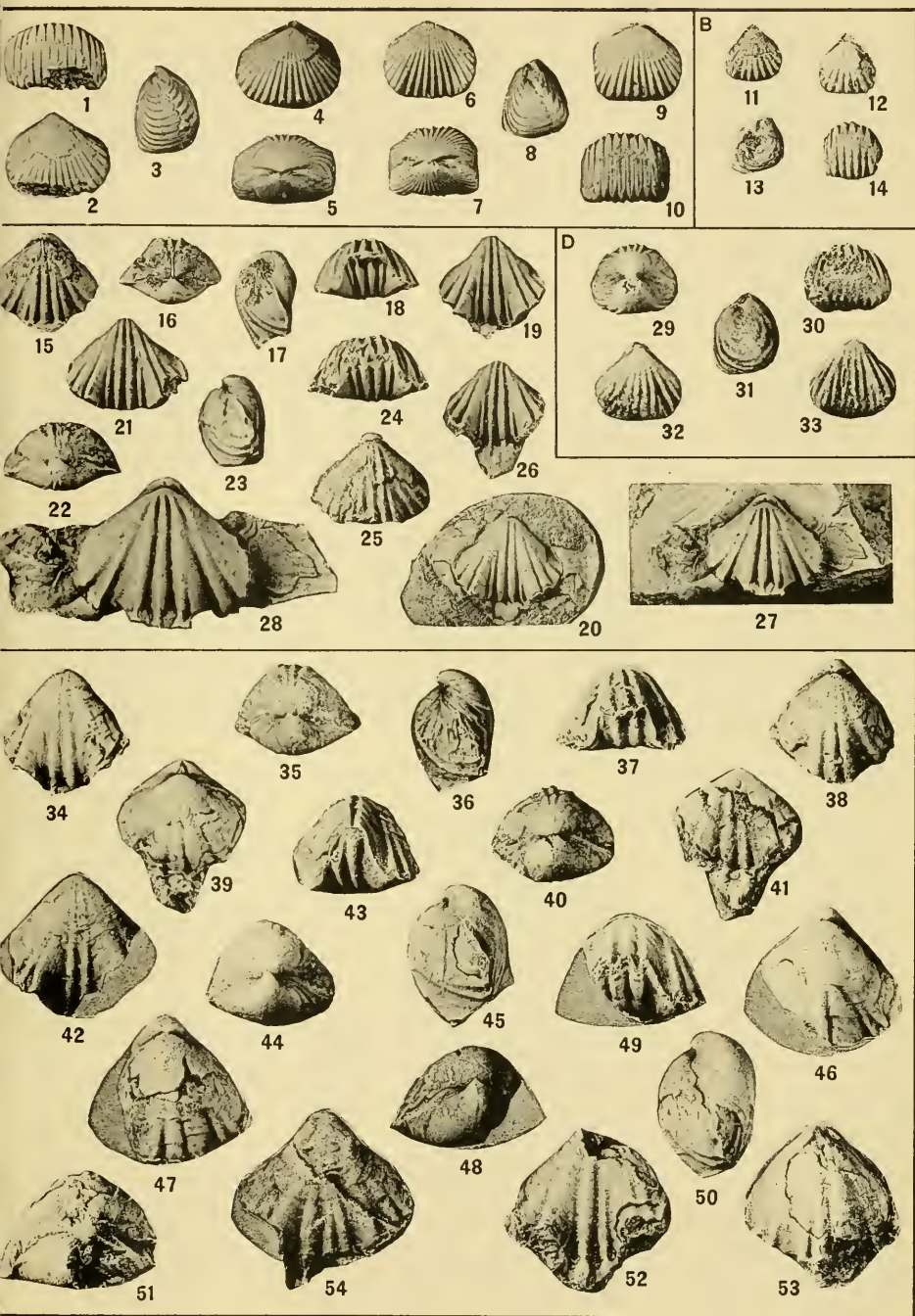


PROBOLIONIA, MARGINIFERA?, AND PLEUROHORRIDONIA?

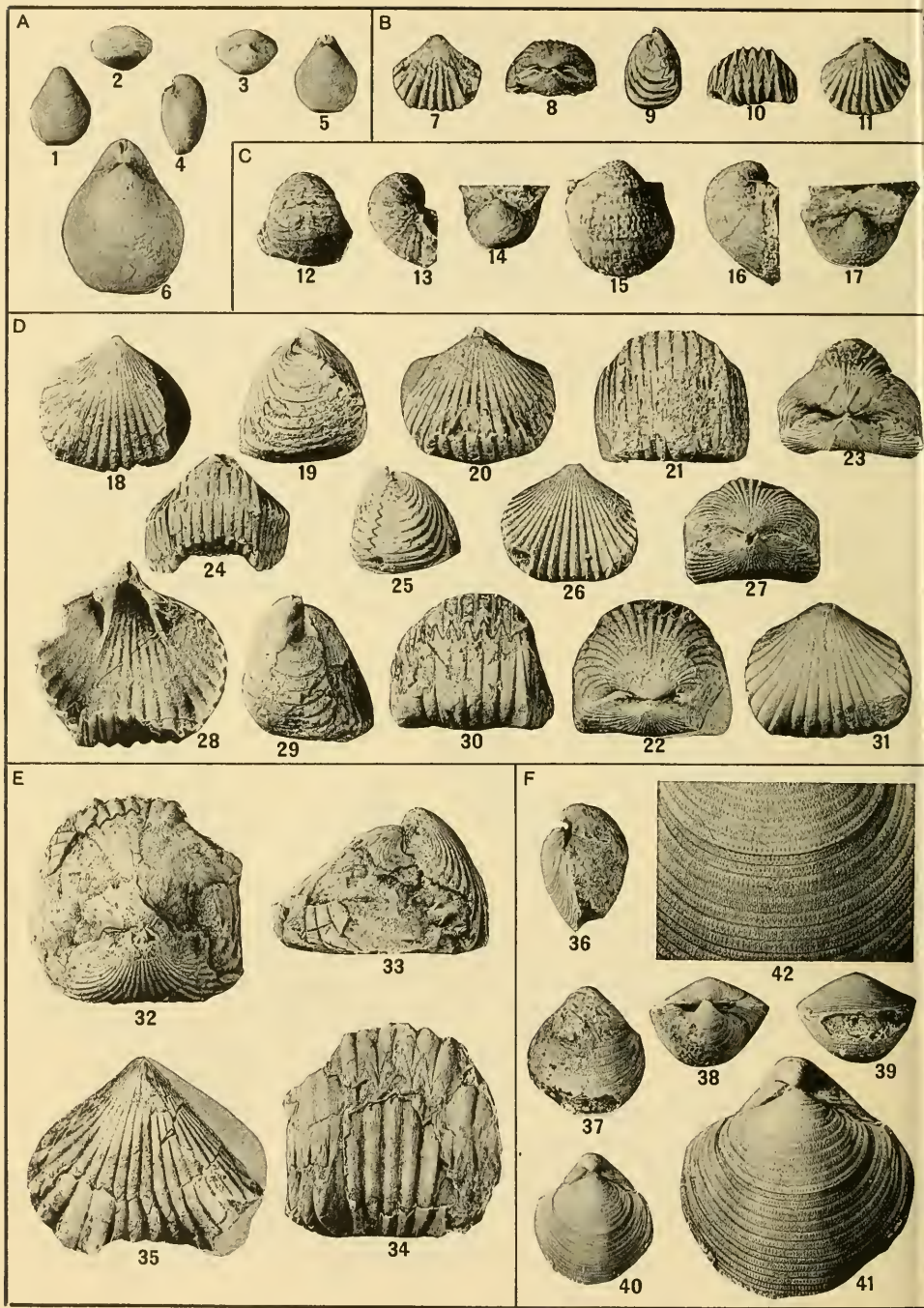
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KROTOVIA, PROBOLIONIA, AND ECHINOCONCHUS
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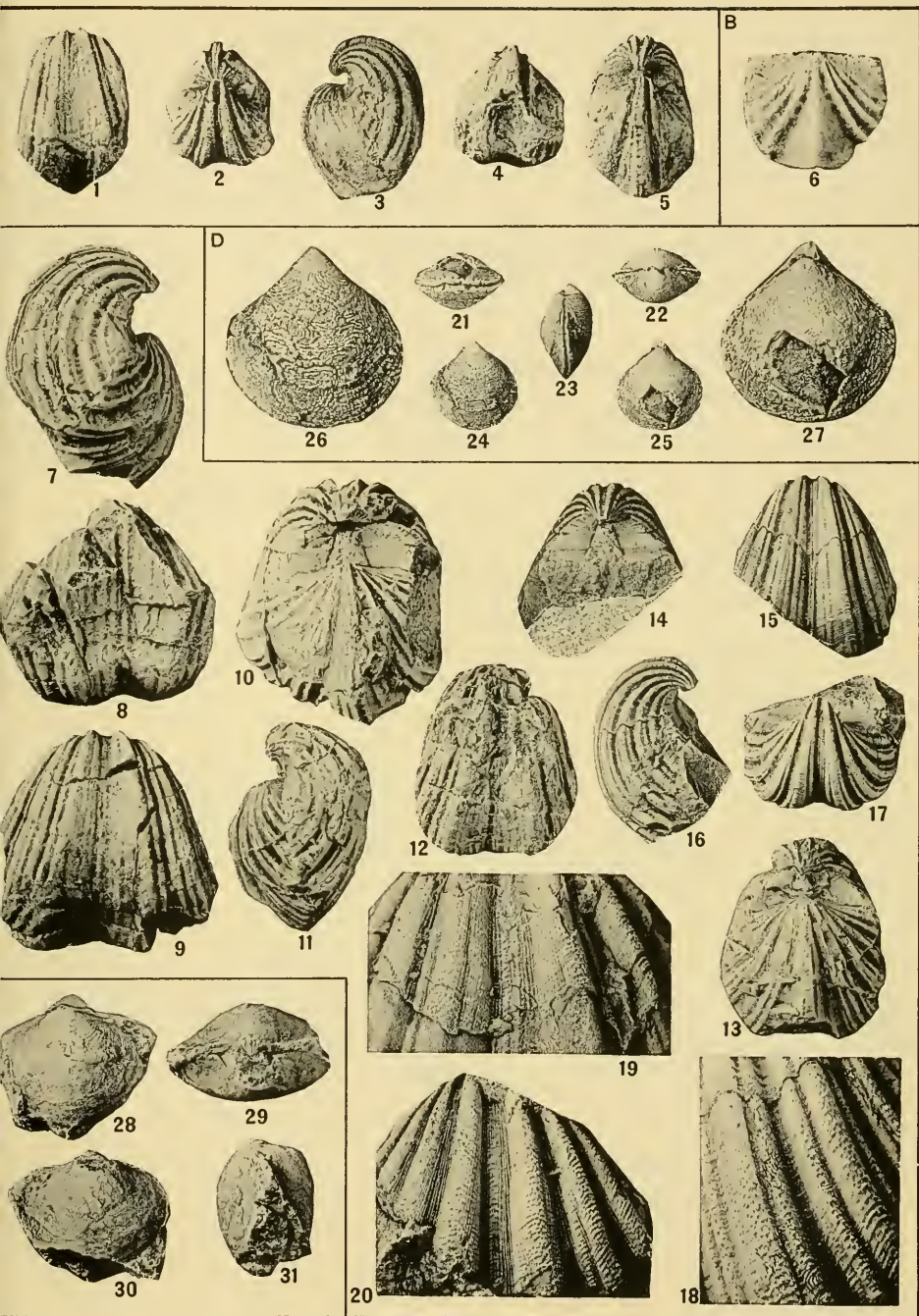


RHYNCHOPORA AND STENOSCISMA
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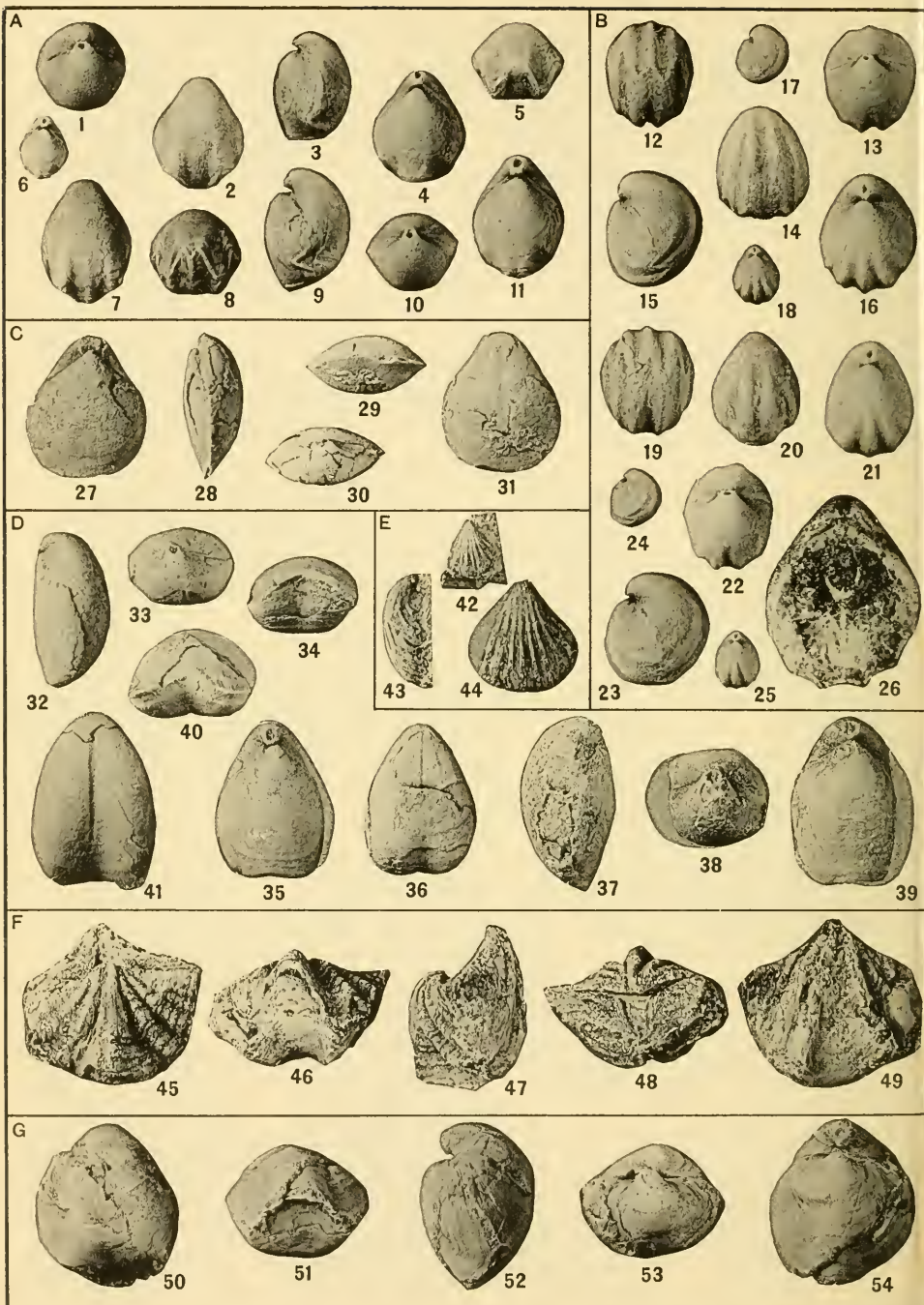
DIELASMA?, WELLERELLA, KROTOVIA, RHYNCHOPORA, STENOSCISMA,
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SPIRIFERELLA, PUNCTOSPIRIFER, AND CLEIOTHYRIDINA

(SEE EXPLANATION OF PLATES AT END OF TEXT)



ROSTRANTERIS, DELASMA, HUSTEDIA, SPIRIFERELLINA, AND PSEUDOMARTINIA
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